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INSTALLATION RESTORATION PROGRAM

PHASE II - CONFIRMATION/QUANTIFICATION

STAGE 1

KIRTLAND AFB
KIRTLAND AFB, NEW MEXICO 87117

PREPARED BY

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MARCH 1985

FINAL REPORT FROM FEB 1983 TO MAR 1985

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

PREPARED FOR

HEADQUARTERS MILITARY AIRLIFT COMMAND
COMMAND SURGEON'S OFFICE (HQ MAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
SCOTT AIR FORCE BASE, ILLINOIS 62225-5001

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5001

INSTALLATION RESTORATION PROGRAM
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FINAL REPORT

FOR

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HEADQUARTERS MILITARY AIRLIFT COMMAND
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SCIENCE APPLICATION INTERNATIONAL CORPORATION
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Preliminary field investigations were conducted at seven potential contamination sources on the lands of Kirtland Air Force Base (KAFB) in the Albuquerque, New Mexico area. These investigations were conducted under the United States Air Force's Installation Restoration Program (USAF IRP) and addressed Phase II (Stage I) - Confirmation/Quantification of said program.

The study sites consisted of five landfills, one fire control training area and one site used for the disposal of irradiated organic materials. Six of the sites are located on the Sandia-Manzano piedmont surface and one lies within the Tijeras Arroyo 100-year flood plain. The climate is semi-arid, receiving <10 inches of precipitation per year typically as brief, intense thunderstorms. Potential evaporation is high (>30 inches). Kirtland AFB abuts the southern boundary of the City of Albuquerque, NM and the study sites are located from one (Cont'd)

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to five miles away from the city's water supply wells. The depth to ground water averages 300 ft. Depth to bedrock ranges from 750 feet to over 3000 feet. The dominant contaminant transport mechanisms are precipitation infiltration and surface water runoff during flood events.

Investigations consisted of aerial image analysis, surface seismic refraction surveys, vertical auger borings, the installation of slant lysimeters and ground water monitoring wells, and chemical anlayses of selected soil and water samples. The lateral and vertical extent of each site were established by surface seismic refraction survey and aerial image anlayses. Analyses of soil and water samples for the indicator parameters of total organic halogens (TOX), total organic carbon, nitrate and selected pesticides indicate an absence of severe environmental degradation. Radiometric monitoring of cuttings and the surface environment yielded no values above background.

Additional data are required at five of the sites before definite conclusions can be drawn. These data should address the status of contamination migration under the study areas and the statistical verification of data in-hand. A ground water level/quality monitoring program is recommended for implementation by KAFB.

PREFACE

This report was prepared for the United States Air Force (USAF) Occupational and Environmental Health Laboratory (OEHL) under contract number F33615-80-D-4002 delivery order 33. This project was completed as part of a program implemented by the United States Air Force called the Installation Restoration Program (IRP). The IRP is the USAF response to the Department of Defense (DOD) Defense Environmental Quality Memorandum 81-5 which requires the identification and evaluation of past hazardous materials disposal sites on DOD lands, the control of contaminant migration and the control of hazards to the public health and environment from past disposal activities. The IRP serves as the basis for response actions at USAF installations under the provisions of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980.

This contract was initially issued to JRB Associates, McLean, VA who in turn funded and and monitored all activities as performed by Science Applications, Inc. (SAI) (parent company to JRB Assoc.) Albuquerque, NM operations. During the course of this investigation SAI changed it's name to Science Applications International Corp. (SAIC).

The IRP is a four-phase program structured as follows:

Phase I -	Problem Identification/Records Search
Phase II -	Problem Confirmation/Quantification
Phase III -	Technology Base Development
Phase IV -	Operations/Remedial Actions

This report addresses Phase II (Stage I) which consisted of the acquisition and analysis of preliminary site-specific environmental field data to identify the status of the environment at each of seven sites and to propose remedial actions where applicable. These sites were identified and prioritized in the IRP Phase I report for KAFB (prepared by Engineering Science, Inc.) as potential contaminant sources.

The responsibilities for executing the major elements of this Phase II (Stage I) effort were delegated as follows:

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The authors of this report would like to acknowledge the following individuals and organizations for their assistance in completing this project: Lt. Col. Steven Robinson (1606th ABW/SGPBE, Kirtland AFB, NM) for his timely assistance in coordinating our efforts with the Kirtland AFB protocols and activities, Capt. Leonig (1606th ABW/ATTV) - pilot and Capt. Wachs (1369th A-V Squadron - Det. 1)-photographer who participated in the photographic mission (the results of which are shown in Section 1); Georgiana Kues (US Geological Survey) for allowing access to provisional USGS water level data, Jake Richardson (KAFB/CES, ret.) and Milton West (KAFB/CES) for basemaps and access to KAFB well

data, Sheryl Olson (SAIC) for single-handly typing this report and Kenneth Brinster and Hector Rede (SAIC) for their constructive input and review of this report.

This work was performed between 10 February 1983 and 7 March 1985. Lt. Col. R.C. Wooten, (USAF OEHL) Technical Services Division, USAF Occupational and Environmental Health Laboratory (USAF OEHL) and Dr. Dee Ann Sanders, (USAF OEHL) were the technical monitors.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

EXECUTIVE SUMMARY

Introduction

This report presents the results of the Phase II confirmation investigations in accordance with the USAF Installation Restoration Program (IRP) at Kirtland AFB, Albuquerque, New Mexico. Investigations were performed to determine if environmental contamination has resulted from waste disposal practices at Kirtland AFB, to provide a basis for evaluating the extent and degree of any contamination discovered and to recommend and prioritize any necessary monitoring or remedial actions. The site investigations were conducted at six sites which were previously identified and prioritized in the KAFB IRP Phase I report (ESI, 1981). The locations of these sites are shown on Figure 1.1 and are described below.

Field reconnaissance was performed at all sites prior to specific data acquisition efforts in order to verify site conditions. Seismic refraction geophysical surveys were conducted at all sites except the FTA and provided information on the vertical and lateral extent of the landfill materials at each site. These surveys, in conjunction with aerial photograph analyses, were used to locate landfill boundaries and identify borehole sites.

The results of the geochemical analyses performed during this study are summarized in Tables 4.1 through 4.3 (pages 4.2 through 4.4) with all the supporting data in Appendix G. These analyses are considered to be indicator parameters and were applied as indicated below:

Site	Sample Type	Analytes
LF-01, LF-02	Water	Haloscan (Organic Chloride, Bromide, and Iodide), Total Organic Carbon and Nitrate Nitrogen.
LF-01, LF-02, LF-03 LF-04 and RB-11	soil (in lieu of lysimeter water)	Haloscan, oil & grease, total lead, sodium and iron and pesticide scan (2,4-D; DDT, p, p'; DDE, p,p'; DDD, p,p'; Dielderin; Aldrin Lindane, Methoxychlor, Heptachlor Epoxide and 2,4,5-T)
FTA	Soil	Haloscan and Oil and Grease

In addition to the geochemical analyses indicated above, a 100-foot deep exploratory borehole was drilled at each site except the FTA with soil samples analysed for grain-size, moisture, density and material classification. These data are summarized in Appendix I (page I-17).

Landfill No. 1 (LF-01) was given the highest priority ranking and is located on the northern rim of Tijeras Arroyo about 800 feet south of the Albuquerque International Airport's east/west runway. LF-01 is reported to have been used as a disposal site for general refuse, although written records were not available for confirmation. The greater portion of the 53-acre site is well covered and graded. The southwestern bank of this landfill contains exposed debris (largely covered during the 1983 summer). The site is crossed by an open, unlined channel that is part of the KAFB storm drain system. Landfill materials do not underlie the channel. The investigation of this site consisted of the drilling of an exploratory borehole, and the installation of two lysimeters and one ground water monitoring well. The conclusions and recommendations for this site are presented at the end of this section.

Landfill No. 2 (LF-02) was given the second highest priority ranking and is located immediately south of the TRESTLE facility. LF-02 is reported to have served as a disposal site for general refuse although written records were not available for confirmation. This site was the subject of local press coverage, wherein Mr. John Beal, truck driver for the American Car and Foundry, an off-base subcontractor to the Atomic Energy Commission (AEC), stated that he had dumped many 55-gallon drums of solvents and plastic wastes in unlined pits over a 22-year period. The 32-acre site is crossed by two pipelines, an effluent-bearing pipeline which carries treated sanitary wastewater and is maintained by KAFB and the Tijeras Interceptor which is a sanitary sewerline maintained by the City of Albuquerque. The effluent pipeline has had a history of failures resulting in the release of liquids on the landfill. A portion of this pipeline was replaced in 1983. This effluent pipeline is used to transfer treated sanitary wastewater to the KAFB Golf Course for irrigation purposes. The site is generally well covered. Cover conditions are variable with numerous surface depressions and soil collapse structures present in the northern portion of the site. The southern boundary

of LF-02 abuts the active channel of Tijeras Arroyo. The investigation of this site consisted of aerial photograph analyses, drilling an exploratory borehole and the installation of two lysimeters and one ground water monitoring well. These efforts did not encounter high soil moisture contents, and geochemical analyses were at or below laboratory detection limits in soil samples. Halogenated organic chloride and bromide were detected at trace levels in the single water sample. The conclusions and recommendations for this site are presented at the end of this section.

The Fire Control Training Area (FTA) was given the third highest priority ranking and is located at the western end of KAFB near the FAA control tower. This 0.7-acre site is currently used to train KAFB Fire Department personnel in fire control techniques. Uncontaminated jet fuel is applied to an aircraft mockup on a cement pad, ignited, and extinguished with standard fire retardant foam. Past training activities at this site were conducted on unprotected soils in the present cement-pad area and were reported to have used small quantities of waste solvents and oil from base shops (ESI, 1981). The investigation of this site consisted of drilling ten shallow boreholes-one boring for background values and nine in the pad area. Elevated levels of oil and grease were detected in soil samples from the pad area. The conclusions and recommendations for this site are presented at the end of this section.

Landfill No. 4 (LF-04) was given the fourth priority ranking and is located in the north-central portion of KAFB, north of the golf course. LF-04 was operated jointly by the City of Albuquerque and KAFB from 1964 to 1969 and is reported to have received general refuse. Written records were not available for confirmation. LF-04 covers 25 acres immediately adjacent to LF-06 which is active and receives KAFB general refuse only. An investigation of LF-06 was not conducted because the site is active. The investigation of LF-04 consisted of drilling an exploratory borehole and installing one lysimeter. All geochemical analyses for this site were below laboratory detection limits. Soil moisture contents at LF-04 are low. The conclusions and recommendations for this site are presented at the end of this section.

Landfill No. 3 (LF-03) was given the fifth priority ranking and is located west of LF-02. This 7-acre site is reported to have received debris moved from LF-02 in preparation for construction of the TRESTLE facility. The

materials buried were largely burned aircraft parts but written records were not available for confirmation. The investigation of this site consisted of drilling an exploratory borehole and installing one lysimeter. The lysimeter did not yield a liquid sample and the soil sample analyzed did not show detectable scan-type parameters. The conclusions and recommendations for this site are presented at the end of this section.

Radioactive burial site number 11 (RB-11) was given the sixth priority ranking of the six sites investigated and is located in the southwest quadrant of the Riding Club, northwest of the Manzano area. This 2.5-acre site received radioactive material in the form of exposed animal carcasses and excreta and contaminated solid and liquid wastes which were buried in at least 9 trenches. Most of the radioactivity is from induced radioactivity and short half-lived elements. Written documentation was unavailable for confirmation. The investigation of this site consisted of the installation of one exploratory borehole and one lysimeter. These efforts did not encounter high soil moisture or detectable indicator parameters above laboratory detection limits. Gamma-ray monitoring of cuttings during drilling yielded no readings above background levels. The conclusions and recommendations for this site are given below.

The conclusions and recommendations generated by this investigation are limited to the extent that the ratios of data points to site size are generally too low to permit a complete evaluation of contaminant nature and extent for all sites except the FTA.

The conclusions arrived at as a result of our investigation are as follows:

1. Based on comparison to detected levels of oil and grease from the background boring FTA-01, the oil and grease contamination at the FTA is restricted to an area coincident to the cement pad to a depth of at least 20 feet. Detected levels of all halogentated organics are within the same range as those found in FTA-01 (250 ft. north of the pad) and are therefore considered to be at background levels or below.

2. The data generated by our investigations are not sufficient to thoroughly characterize the nature or extent of potential subsurface contamination at the LF-01, LF-02, LF-03, LF-04, and RB-11 sites.

3. Ground water monitoring wells located downgradient from LF-01 and LF-02 do not show significantly elevated levels of analytes. These findings must be verified by additional sampling.

4. LF-02 lies in the Tijeras Arroyo flood plain and is in contact with the active channel of Tijeras Arroyo. This is causing degradation of the downstream environment by the surface transport of debris.

Our recommendations for the future KAFB IRP studies are summarized in Table 1 (see Page 8). These recommendations are classified as alternatives in the major categories as follows: Alternative I - Long-Term Monitoring (LTM (option selected); Alternative II - Additional Data Acquisition; Alternative III - Maximum Data Acquisition; and Alternative IV - Other Considerations. Alternatives I, II, and III are ranked according to priority and their corresponding specific actions are also ranked in numerical order. Please note that Alternative IV, "Other Considerations," presents ranked activities that are less critical than Alternatives I, II, and II, and, in fact, is not an alternative per se.

Alternative I (see Table 1) is the alternative of choice the Air Force has decided to pursue under the current IRP format. While the KAFB data are not comprehensive, they do generally indicate a lack of widespread environmental degradation due to past disposal practices. The choice of Alternative I is clearly the best choice based on the data generated by this study, and it will ensure protection of the public health as well as preservation of the surrounding environment. LTM will also serve to identify any future mobilized contaminants in the water table and in the shallow subsurface environment. Selection of Alternative I was heavily influenced by the following environmental factors:

a. KAFB is located in the arid Southwest and receives an average of 8.4 inches of precipitation per annum. Thus, the potential for continuous vertical contaminant transport by water is lower than that for other climes.

b. The vadose zone is typically greater than 300 feet thick under KAFB and SAI has documented zones containing as little as 2% soil moisture in the upper portions of this unit. These data indicate a low probability of saturated connection between the study areas and the water table.

Note further that Alternative I (see Table 1) also includes the Phase II/IV work required to locate and dispose of the reported 55-gallon drum of mercury. The drum should be readily identified using geophysical techniques and should be easy to remove.

The activities recommended under Alternative II, Additional Data Acquisition, are intended to supplement the data base developed by SAI during Phase IIB. These data would be required in order to develop additional evidence to reach a final conclusion as to the presence or absence of hazardous materials at the sites studied. Prior to the initiation of Phase IIB activities, there were no geochemical data available for the landfills. Of the proposed additional data acquisition efforts at LF-01, LF-02, and RB-11, those addressing LF-02 are the highest priority due to allegations that it contains waste solvents and plastic residue generated by a former AEC plant, its location in the Tijeras Arroyo flood plain, and its large size (32 acres). LF-01, RB-11, and LF-04 require additional data to substantiate the Phase IIB findings. The investigation of LF-04 can be postponed until LF-06 (active) is closed and the area then studied and monitored as a single site.

The proposed landfill redressing under Alternative II is dependent on the nature of the data generated by the actions proposed under this alternative. Of the sites recommended for redressing, LF-01 and LF-02, LF-02 has highest priority based on its location in the Tijeras Arroyo flood plain and contact with the active channel. This alternative also calls for the location/removal of the reported 55-gallon drum of mercury. Further, despite the lack of an extensive data base generated by the Phase IIB effort, this alternative calls for the investigation at LF-03 to be terminated because of the location, condition and history of the site. In addition to the actions proposed above under this alternative, all Alternative I actions would also be included.

Alternative III includes all activities recommended under Alternative I as well as the additional data acquisition activities under Alternative II for LF-01, LF-02, and RB-11. This alternative would also include LF-04 for additional data acquisition. In addition, the surfaces at LF-01, LF-02, and LF-04 would be redressed to prevent surface transport of exposed landfill material, to reduce infiltration potential, and, at LF-02, stabilize the

surface to reduce ill effects from flooding in the Tijeras Arroyo. The efforts at the FTA would consist of the drilling and sampling of a borehole in the area of boring FTA-10 to a maximum depth of 100 feet. This effort would identify the lower limit of oil and grease contamination. Consideration should be given to the computer modeling of transit times at the FTA based on the additional data. In addition, the FTA sprinkler and pressure tank would be pressure tested, fuel inventory monitored closely, and the pad resealed as well as the drain line plugged. Under this alternative, LF-04 would be further investigated with the drilling and sampling of several boreholes in the central and eastern portions of the landfill. This drilling would target the first 30 feet of native materials under the fill. These additional investigations at LF-04 can be coordinated with the LF-06 closure. LF-03 would be considered closed with respect to the KAFB IRP.

Alternative IV, Other Considerations, includes ranked actions that are not as critical as other actions outlined in Alternatives I, II, and III, and can be considered for implementation at any time. The two major actions in this category are as follows. A comprehensive study of the Tijeras Arroyo as a system is recommended to define the potential contaminants in the Arroyo upstream, adjacent to and downstream of LF-02, and evaluate potential impacts. The effects of LF-02 cannot be properly assessed without background data due to the presence of an abandoned City of Albuquerque landfill approximately two miles upstream. Downstream investigations are necessary to document the presence or absence of contaminant transport into populated areas. The computer modeling of subsurface transport phenomena is recommended to provide an estimate of travel times based on local conditions. This computer modeling will require the acquisition of specific field data to be used as input. The other action would be to search the literature to locate and define mathematical modeling programs that would predict contaminant transport times under unsaturated conditions in stony soils. The model would then be applied to all study sites as applicable.

Table 1. Summary of Recommendations

Alternative	Nature of Action	Rationale
I. Long-Term Monitoring (Including Data Acquisition and Remedial Action)	1. DM-01 and DM-02 (annual or semi-annual) Initial sampling for Interim Primary, Proposed Secondary, and nonredundant Priority Pollutants, then repeat every 6-8 sampling events. Interim sampling for analytes showing positive from initial sampling plus Oil and Grease (O&G), TOX, and N.	1. a. Documents water quality downgradient from landfills. b. Provides statistically defensible data base for water quality variations or degradation. c. First wells to degrade if contaminants are mobile.
	2. KAFB production wells 2, 4, 6, 7 and 8 on same schedule as DM wells.	2. Same as 1.
	3. Magnetometer survey of RB-11.	3. Locate reported 55-gal. drum of mercury.
	4. Waste removal and site reclamation at RB-11.	4. Remove and properly dispose of mercury drum and seal surface from infiltration.
	5. Terminate IRP for LF-01, LF-02, LF-04, and FTA.	5. a. Area climate indicates a very low potential for vertical transport of contaminants - high evapotranspiration. b. Area hydrogeology indicates extremely low probability for saturated connection between study sites and water tables.

Table 1. Summary of Recommendations (Continued)

Alternative	Nature of Action	Rationale
II. Additional Data Acquisition (Including Monitoring and Remedial Action)	1. Expand areal distribution of data beneath LF-01, LF-02, and RB-11. Penetrate fill at LF-01 and LF-02 with angle holes at RB-11.	1. For analysis of status of contaminant migration under referenced sites.
	2. Redress surfaces of LF-01 and LF-02.	2. a. Prevent surface transport of exposed landfill material b. Reduce infiltration potential c. For LF-02; stabilize surface with respect to potential flooding in Tijeras Arroyo
	3. Terminate IRP for LF-03.	3. Site well covered, small, well located and negative initial contaminant identification.
	4. Terminate IRP for LF-04.	4. Postpone additional study until landfill LF-06 (active) is closed.
	5. Terminate IRP for FTA.	5. Data collected already considered adequate.
	6. Actions Nos. 1-4 under Alternative I.	6. See Alternative I.

Table 1. Summary of Recommendations (Continued)

Alternative	Nature of Action	Rationale
III. Maximum Data Acquisition (Including Monitoring and Remedial Action)	1. Expand areal distribution of data beneath LF-01, LF-02, LF-04, and RB-11. Penetrate fill at LF-01 and LF-02 with angle holes at RB-11.	1. For analysis of status of contaminant migration under referenced sites.
	2. Redress surfaces of LF-01, LF-02, and LF-04.	2. a. Prevent surface transport of exposed landfill material. b. Reduce infiltration potential. c. For LF-02; stabilize surface with respect to potential flooding in Tijeras Arroyo.
	3. Monitor fuel inventory, pressure test sprinkler and tank, seal pad and plug drain line at FTA.	3. Reduce potential future degradation.
	4. Terminate IFP for LF-03.	4. Site well covered, small, well located and negative initial contaminant identification.
	5. Additional drilling/sampling of FTA.	5. Verify vertical extent of O&G contamination.
	6. Soil sampling south of FTA.	6. Outfall ponding area of FTA and industrial shop area NW of KAFB and runway.

Table 1. Summary of Recommendations (Continued)

Alternative	Nature of Action	Rationale
III. Maximum Data Acquisition (Continued)	7. Actions Nos. 1-4 under Alternative I.	7. See Alternative I.
IV. Other Considerations	1. Determine potential contaminants in Tijeras Arroyo upstream, adjacent to and downstream of LF-02.	1. a. Evaluate potential impact of contaminant transport in Tijeras Arroyo adjacent to LF-02. b. Concern expressed by EPA.
	2. Locate and define data requirements for unsaturated flow transport model.	2. To provide estimated travel time of contaminants to ground water.

1.0 INTRODUCTION

Science Applications, Incorporated, (SAI) was retained by JRB Associates for the Occupational and Environmental Health Laboratory (OEHL), Brooks AFB, TX, to study selected waste disposal sites at Kirtland Air Force Base, Albuquerque, New Mexico. The purpose of this study was to assess the hazard potential of selected waste disposal sites, to determine if any contaminants are migrating from the disposal sites, and to propose remedial actions where necessary. SAI conducted this study in two phases, Phase IIA and Phase IIB. Phase IIA (presurvey) was completed in August 1982 and Phase IIB was executed between February 1983 and March 1984. This report presents the findings of the Phase IIB field and analytical efforts.

This study of the hazard potential of disposal sites at Kirtland AFB was performed as part of an ongoing Department of Defense program entitled the Installation Restoration Program (IRP). The purpose of this program is to systematically identify, assess and control any environmental degradation caused by past waste disposal practices at military installations. The IRP program is typically executed in four phases:

Phase I -- Problem Identification/Records Search
Phase II -- Problem Confirmation/Quantification
Phase III -- Technology Base Development
Phase IV -- Operations/Remedial Actions

SAI's efforts at Kirtland AFB address Phase II of the IRP program.

Phase I of the Kirtland Air Force Base (KAFB) Installation Restoration Program (IRP) was conducted by Engineering Science, Incorporated (ESI) with the results of their investigations reported in November, 1981. This report consisted of a search of pertinent installation records, a literature search of published and unpubiished reports, discussions with key installation personnel (both active and retired), an examination of topographic and geologic maps, an examination of aerial photographs, site visits, and an assessment of the hazard potential of each waste disposal site. Phase I identified twenty-one (21) disposal sites on KAFB lands as potential contamination sources which were prioritized for Phase II evaluation and

remedial action planning. The following sites (Figure 1.1) were identified and prioritized for monitoring and possible remedial action using criteria described in Phase I:

1) Landfill No. 1 (LF-01)
2) Landfill NO. 2 (LF-02)
3) Landfill No. 3 (LF-03)
4) Landfill No. 4 (LF-04)
5) Radioactive Burial Site No. 11 (RB-11)
6) Fire Control Training Area (FTA)
7) Landfill No. 6 (LF-06).

The study of LF-06 was considered as part of the LF-04 investigation due to its low priority ranking and proximity to LF-04. LF-06 is currently an active operation, accepting KAFB-generated refuse only. Disposal activities are monitored and the LF-06 site is completely enclosed by a chain-link fence.

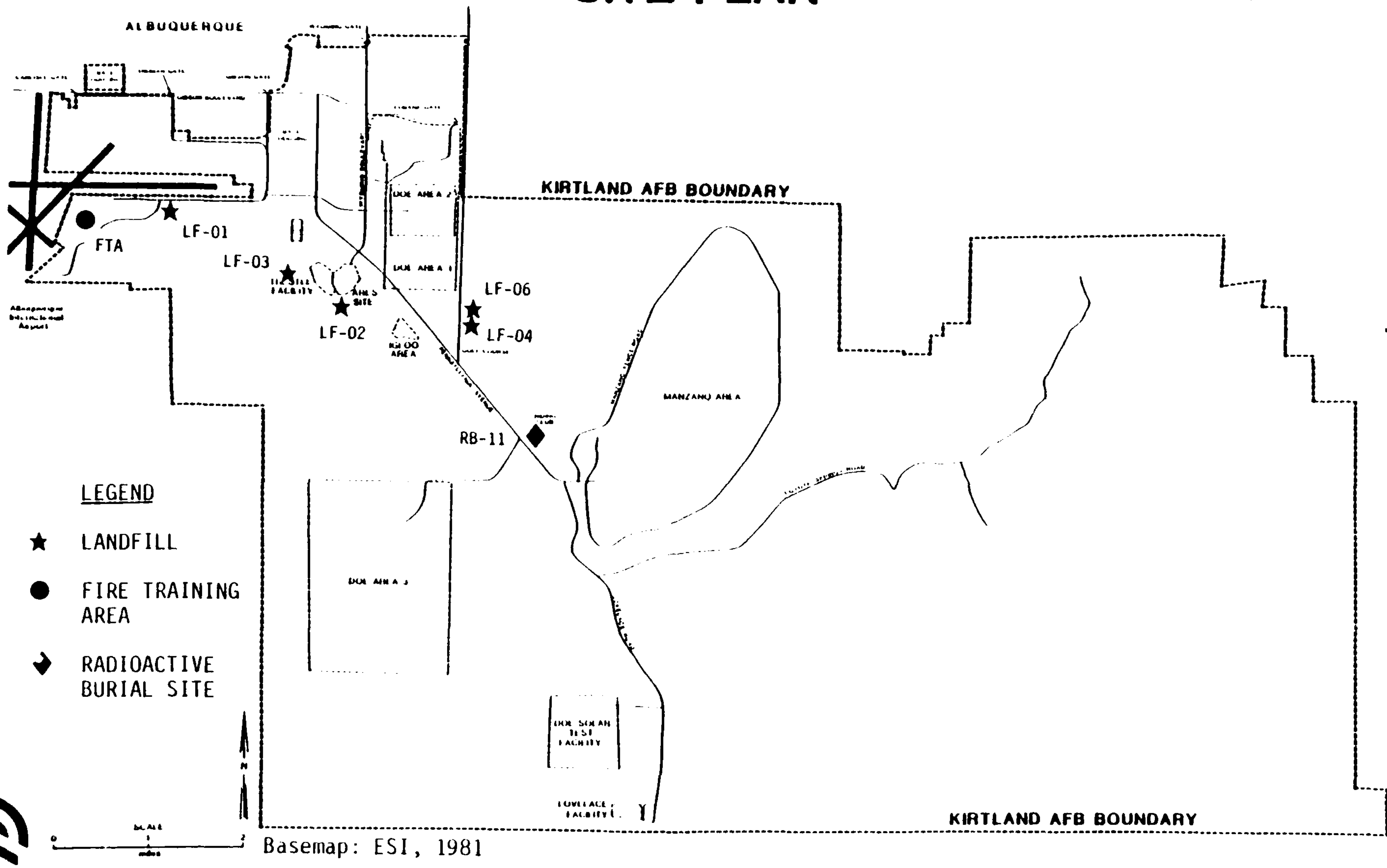
1.1 BACKGROUND

Kirtland AFB is located in central New Mexico, southeast of and adjacent to the City of Albuquerque, NM (Plate I, in pocket). The area designated as Kirtland AFB includes lands and facilities owned and operated by the US Air Force, three areas owned by the Department of Energy (DOE) with facilities operated and maintained by Sandia National Laboratories, lands leased from the U.S. Forest Service and several off-base facilities. At present, the basic missions of KAFB are to support research and development and to train pararescue medics (ESI, 1981). The details regarding these resident units and their respective missions are presented in ESI's Phase I report.

Since the initiation of construction activities in 1941, the KAFB area has been administered by a variety of military organizations with missions typically directed to aviation training and miscellaneous research activities.

No written records regarding the nature of wastes generated or of disposal activties prior to 1960 were found during the course of Phase II investigations. General refuse generated by KAFB is currently placed in Landfill 6 and activities are monitored by KAFB personnel. This Phase IIB study addressed only the sites indicated in Section 1.0 above.

FIGURE 1.1
KIRTLAND AFB
SITE PLAN



Basemap: ESI, 1981

Kirtland AFB (KAFB) and the City of Albuquerque rely heavily on the Santa Fe Formation aquifer as a source of large quantities of potable water. Over half of KAFB and all Phase IIB study sites overlie the Santa Fe Formation. The water table occurs at depths of 300 to 400 feet below ground surface at the landfill sites and the potential for a saturated connection (and potential contaminant migration) between the landfills and the water table is low.

There have been reports of ground water contamination in the Albuquerque, NM, area since 1977 (McQuillan, 1982). These reports have been concerned with excessive nitrate concentrations in the Mountainview subdivision area and at various locations in Tijeras Canyon (see Plate I). A state regulatory agency, the New Mexico Environmental Improvement Division (NMEID), and the EPA Region IV office have indicated that Kirtland AFB waste disposal practices are not considered to be contributors to the degradation of ground water in the Mountainview area (McQuillan, (1983)-personal communication). This opinion has not been fully verified by previous studies or by this Phase II study. The reported Tijeras Canyon nitrate contamination sites are located hydraulicaly up-gradient from KAFB and are thought to be independent of base activities. The regional geochemistry and water quality are discussed in Sections 2.5 and 2.6 of this report.

1.2 SITE DESCRIPTIONS

The following sections describe the general physical characteristics of each site. The environmentally significant factors and background data for each site have been included. No prior geochemical analyses were available for the study areas. The findings of field investigations are summarized in Section 4 and Appendix K. The site cross sections presented here are discussed in Section 4.

1.2.1 Landfill Number 1 (LF-01)

LF-01 is located in the NW sec. 2, T.9 N., R.3 E. and the NW sec. 1, T.9 N., R.3 E. This site is bounded to the north by Kirtland Road, to the south by a spur of the Atchison, Topeka and Santa Fe Railroad (AT&SF) to the east by an access road to a munitions storage area and igloo area and to the west by a line taken from the southwest corner of the landfill scarp to a prominent turn

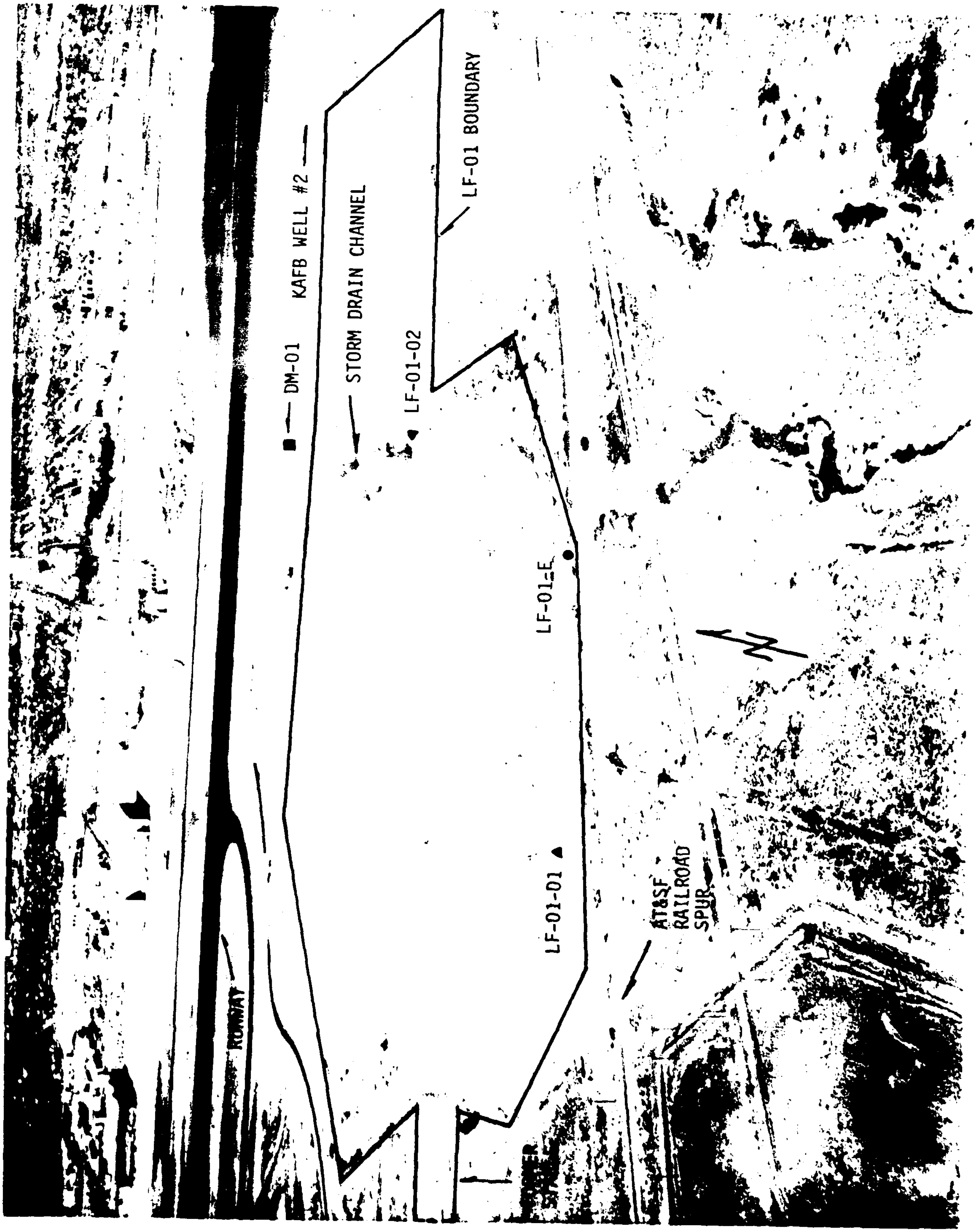
in Kirtland Road. The elevation of the site ranges from 5255 to 5323 feet, MSL in the north. The site is divided into two parts by a modified natural channel that serves as part of the Kirtland AFB surface drainage system (Figure 2.7) and is typically dry, running only in response to local precipitation events. The channel passes through a culvert under the AT&SF railroad spur and joins Tijeras Arroyo about one mile to the south. Channel conditions indicate that runoff from recent precipitation events has infiltrated into the channel bottom before reaching the railroad spur. Plate I shows the location of the site relative to regional features and Figure 1.3 shows the details of the site with the best available topographic control. The topography in the area, designated as "Abandoned Sanitary Landfill", has been modified by KAFB waste disposal activities since the topographic map was constructed.

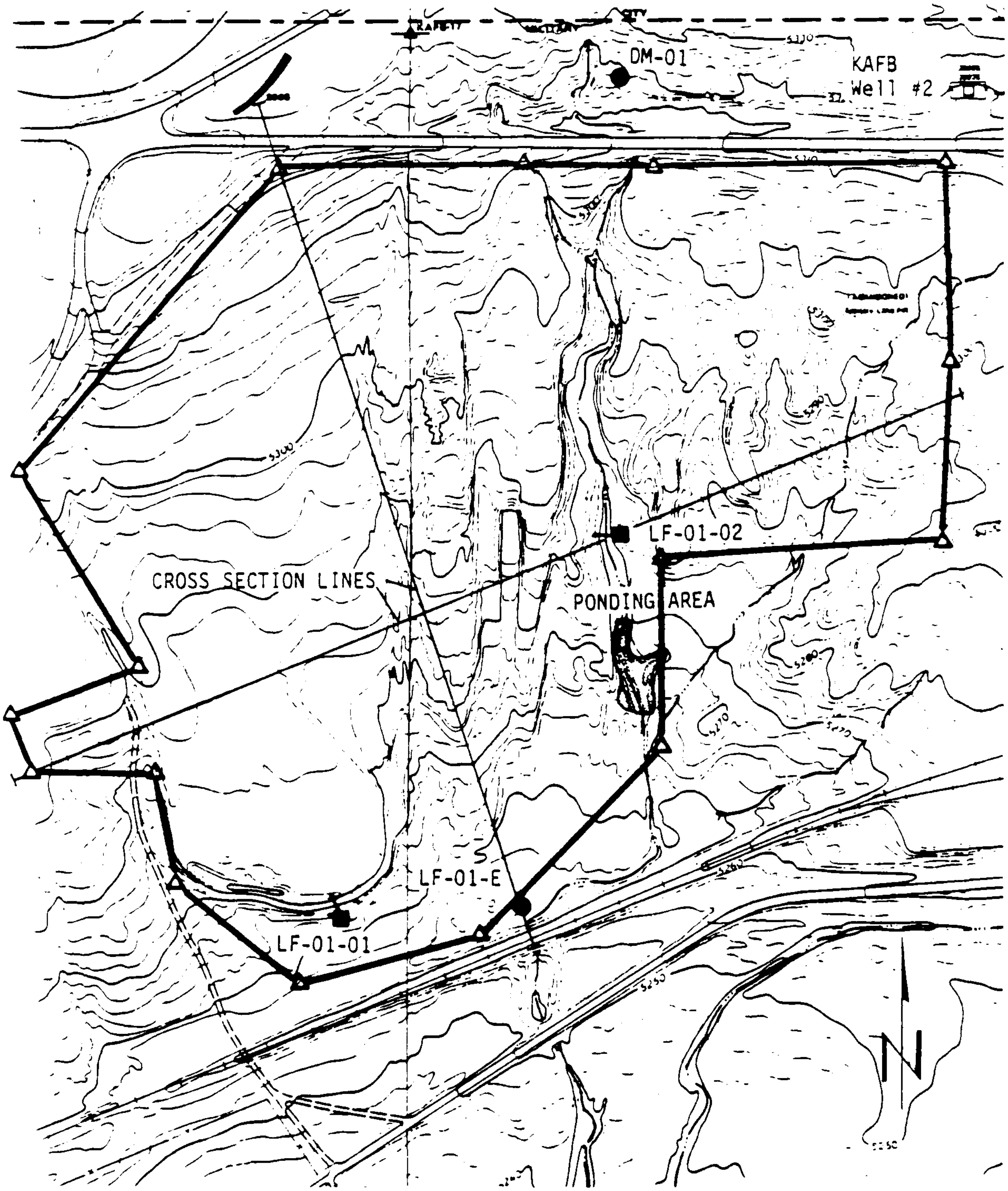
The LF-01 site was operated from 1965 to 1975 (ESI, 1981). No written records of the quantities or nature of the materials disposed in LF-01 were found during the course of this investigation. A review of the KAFB aerial photograph archives revealed coverage from 1971 at a scale of about 1 inch = 400 feet. At that time, disposal activities were centered in the central part of the study area, west of the runway drainage. The 1971 photos indicate that waste materials were of various types, ranging from numerous 55-gallon drum-type containers, to building debris, to tree stumps. A riding stable was formerly located adjacent to the landfills western edge (KAFB Records, 1971) and has been included as part of LF-01.

The 1971 aerial photos indicate that disposal activities had not been initiated in earnest east of the runway drainage. This eastern portion of LF-01 has since been filled and is currently well covered and evenly graded (Figure 1.2).

Interviews with KFAB personnel involved with the operation of LF-01 confirmed the locations of the proposed landfill boundaries but the interviewees could not recall the nature of the materials buried.

Figure 1.2 Landfill No. 1 (LF-01)





Basemap: KAFB/CES, 1976

SCALE

300 150 0 300 600 ft.

LEGEND
SEE FIGURE 1.21

Contour Interval = 2 ft.

Figure 1.3 Landfill No. 1 (LF-01) Topographic Map

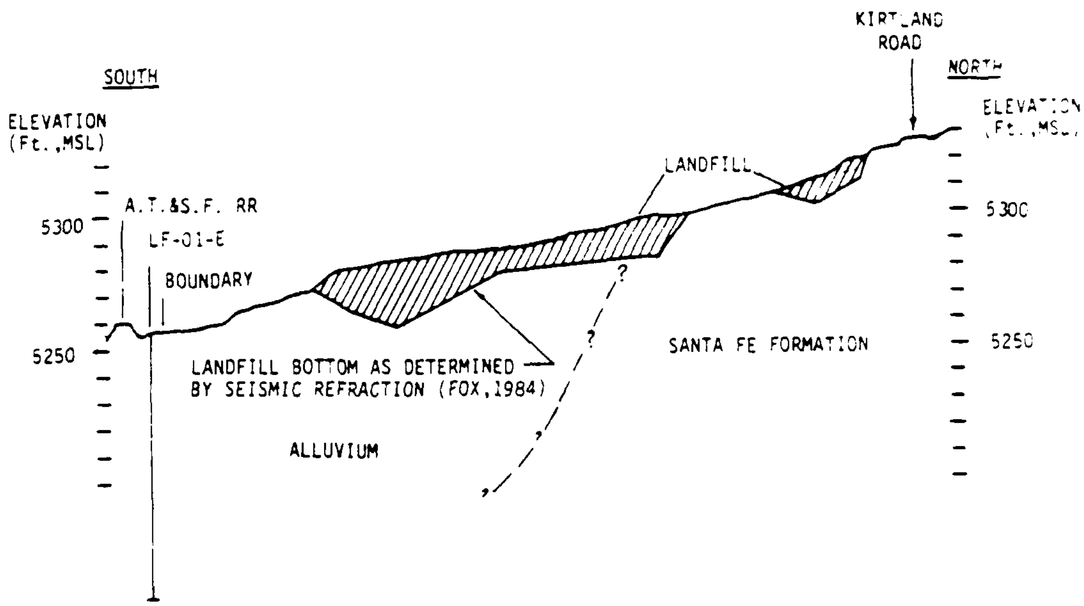
The LF-01 site lies in an ancient head-cut of an old arroyo that existed before Tijeras Arroyo developed its present course (Figure 1.4). This head-cut is in unconsolidated and semiconsolidated sediments of the Ceja Member of the Santa Fe Formation. The characteristics of the Santa Fe Formation are described in Section 3.3 of this report. There are no geologic structures within 2 miles of the LF-01 area.

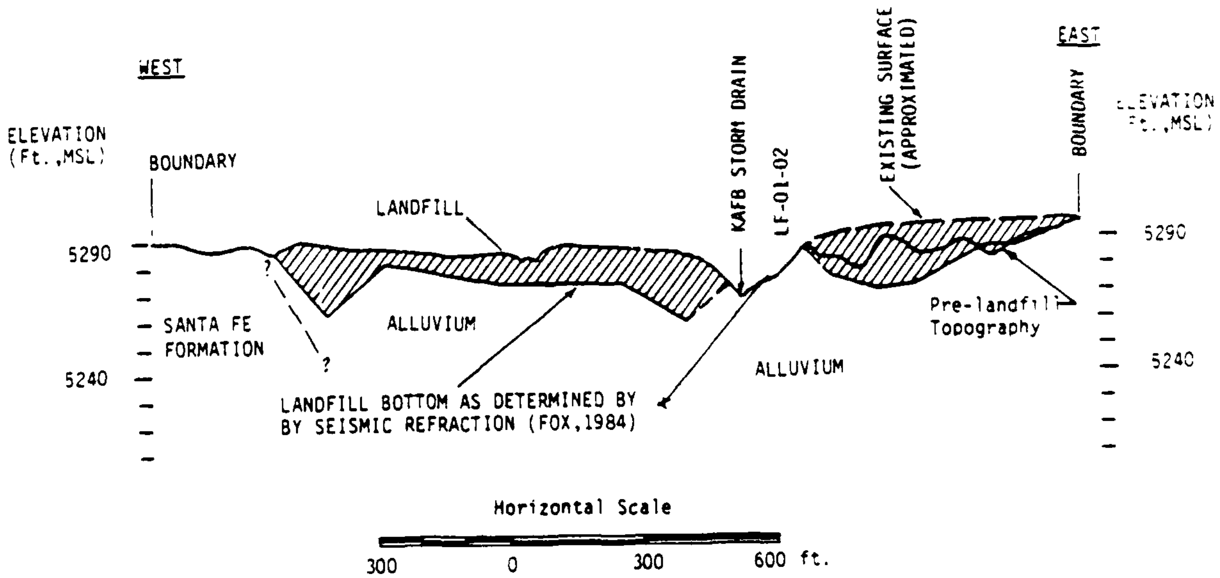
The depth to the water table in the LF-01 area is about 420 feet (4895 ft, MSL). The hydraulic gradient is to the north at seven feet per mile. KAFB production well #2 is located about 150 feet northeast of the northeast corner of LF-01. Monitoring well DM-01 was installed approximately 150 feet north of LF-01. The cuttings description for this well is located in Appendix E and indicates that the Santa Fe Formation persists to a depth of at least 480 feet Water level monitoring at DM-01 conducted during February, 1984, indicated a depth to water of 421 to 422 feet (See Appendix E).

1.2.2 Landfill Number 2 (LF-02)

LF-02 is located in the NE sec. 7, T.9 N., R.4 E. This site is bounded to the north by the TRESTLE and ARES Facilities and to the south by the present-day, active channel of Tijeras Arroyo. The eastern and western boundaries are less well defined and are located at the limits of selected man-made surface disturbances. LF-02 site lies entirely in the Tijeras Arroyo flood plain at elevations ranging from 5243 feet, MSL in the west to 5278 feet, MSL in the east. The active Tijeras Arroyo channel is in contact with LF-02 for about 4500 feet along the south boundary and has cut below the flood plain surface to depths of about 3 to 16 feet. Plate I shows the location of LF-02 relative to regional features and Figure 1.6 shows the site with the best available topographic control.

LF-02 was operated from 1943 to 1965 (ESI, 1981, Fox, 1984). No written records of the quantities or nature of materials disposed at this site were found during this investigation and no historical aerial photographs were available for LF-02 from the KAFB archives. Site LF-02 became the object of local press coverage when a Mr. John Beal (truck driver for the American Car and Foundry (ACF) a subcontractor to the Atomic Energy Commission) stated that from 1955 to 1967 he had delivered a large quantity of liquid solvents and



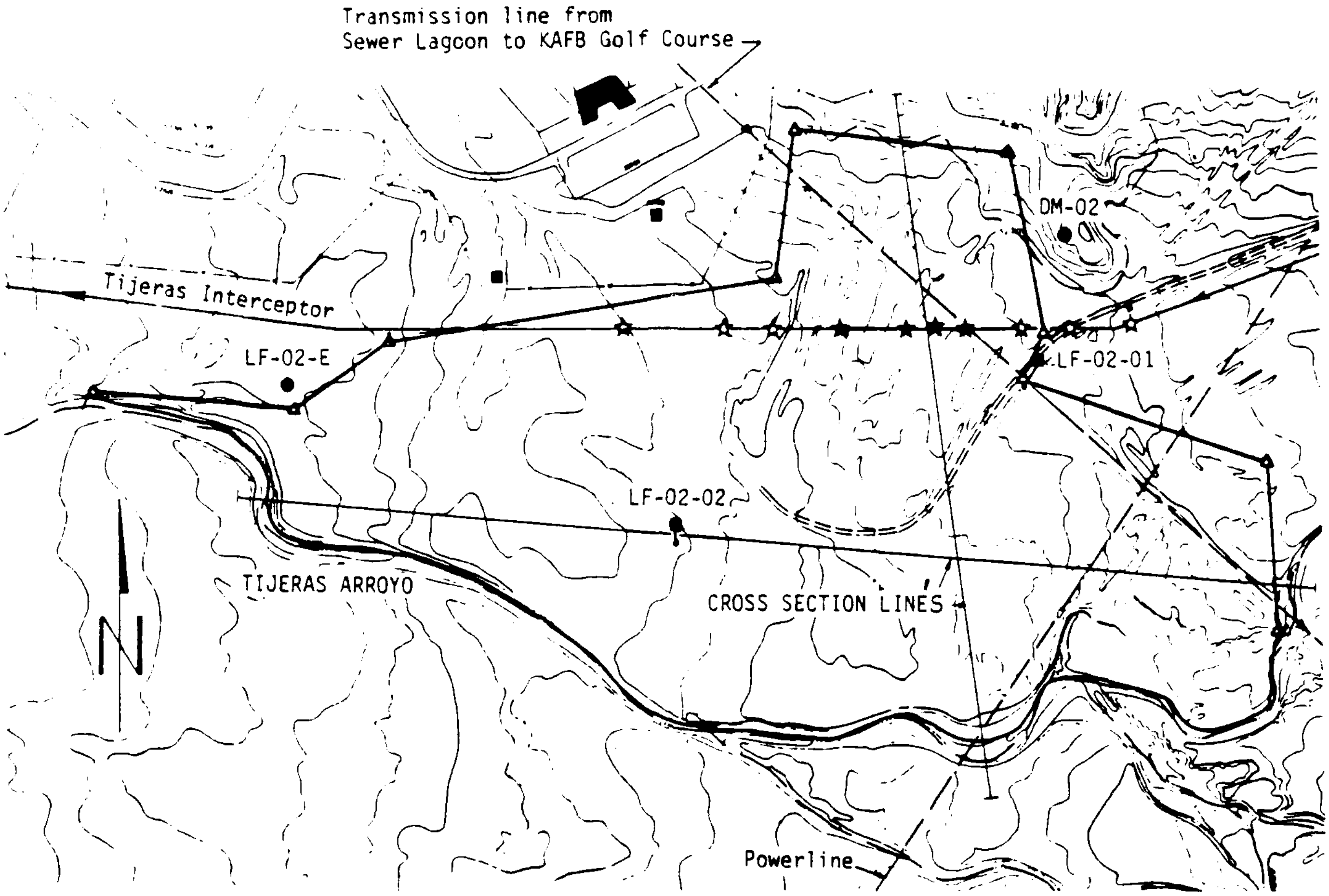


LEGEND

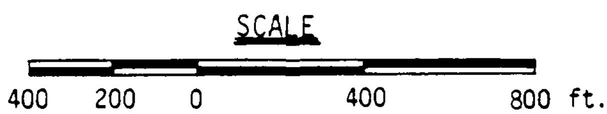
SEE FIGURE 1.21

Figure 1.4 Landfill No. 1 (LF-01) Cross Sections

Figure 1.5 Landfill No. 2 (LF-02)



Basemap: KAFB/CES, 1976

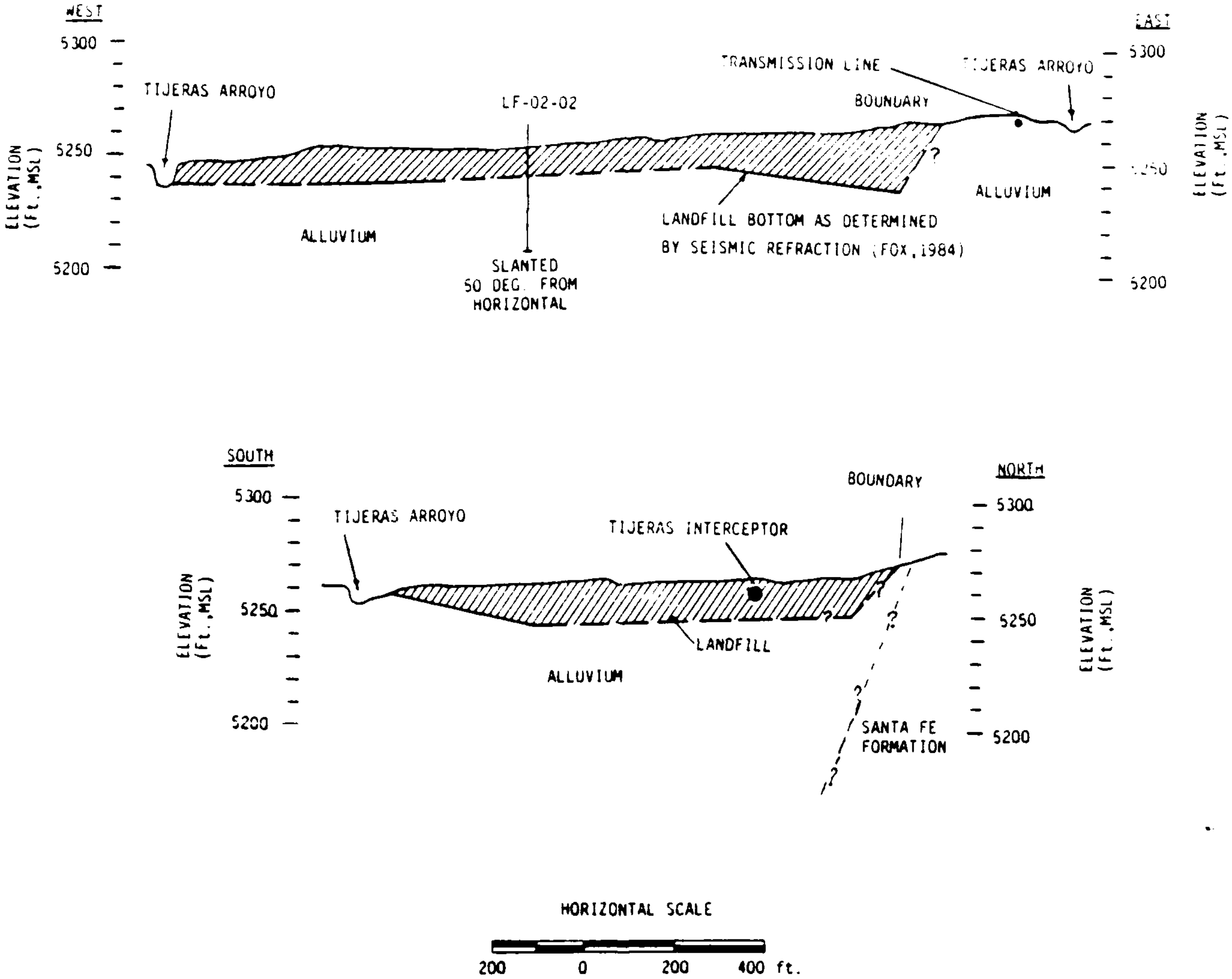


Contour Interval = 2 ft.

LEGEND

SEE FIGURE 1.21

Figure 1.6 Landfill No. 2 (LF-02) Topographic Map



LEGEND

SEE FIGURE 1.21

Figure 1.7 Landfill No. 2 (LF-02) Cross Sections

plastic wastes to the LF-02 site for disposal in unlined trenches. These materials were generated off-base at the ACF plant at Broadway and Woodard SE (operated by General Electric since 1967) which was involved with making classified nuclear warhead components for the AEC. (Albuquerque Journal, 25 April 1982). As of June, 1983, independent water quality sampling performed by the NMEID showed no traces of solvents in the Mountain View area about 4 miles west of KAFB near the confluence of the Rio Grande and Tijeras Arroyo (Albuquerque Journal, June 2, 1983). The Mountainview area has had a 20-year history of nitrate/nitrite concentrations in excess of health standards (McQuillan, 1982) and is currently under investigation by state and federal agencies (See Sections 2.5 and 2.6 of this report).

The depth to the water table in the LF-02 area is about 379-380 feet (4900 ft, MSL). The hydraulic gradient is to the north at 8 to 10 feet per mile. KAFB production well #8 is located about 2100 feet northeast of the northeast corner of LF-02. Monitoring well DM-02 was installed approximately 125 feet northeast of the east edge of LF-02. A cuttings log for this well is located in Appendix E and indicates that the Santa Fe Formation persists to a depth of at least 450 feet. Water level monitoring conducted at DM-02 during February 1984 indicated a depth to water of 379-380 feet (See Appendix E).

During construction of the nearby TRESTLE Facility in the mid-1970's, the northernmost portion of LF-02 was exhumed and relocated to the present day LF-03 site. The extent of the relocation effort in the LF-02 area is not known. The results of test borings for the construction of the TRESTLE Facility were not available for this investigation.

LF-02 is crossed by two pipelines, the Tijeras Interceptor Sanitary Sewer Line, and a transmission line from the Sanitary Sewer Stabilization Lagoon to the KAFB Golf Course. The City of Albuquerque maintains the Tijeras Interceptor, which is a 21-inch diameter sanitary sewer line that trends generally east-west and crosses the northeast portion of LF-02 about 200 ft south of well DM-02. Completion documents filed with the City of Albuquerque by Molzen-Corbin and Associates (1977) indicate several test borings were made during the construction of the Tijeras Interceptor and encountered landfill materials. These borings show a cover thicknesses 2 to 6 feet with the refuse

ranging from 9 feet to over 13 feet thick. (See Appendix E and Figure 1.7). In the vicinity of LF-02 collapse structures are commonly associated with the Tijeras Interceptor, especially near manholes. The trace of the Interceptor supports anomalously dense vegetation (Silva, 1983-personal communication).

The treated effluent transmission line from the KAFB Sewage Stablization Lagoon to the KAFB golf course trends southeast from the common fence corner area of the TRESTLE and ARES facilities to the southeast corner of LF-02, crosses Tijeras Arroyo, and passes through part of Arroyo del Coyote to the KAFB Golf Course. This transmission line has had a history of failures causing localized liquid releases in the LF-02 area (Glasgow, 1983, personal communication). Aerial photographs obtained during Phase IIA reconnaissance (spring, 1983) also show anomalously dense vegetation growth along parts of this transmission line (Silva, personal communication, 1983). During the period of the Phase IIB study, a portion of this transmission line was replaced with a 14-inch, continuous polyethylene pipe.

LF-02 lies within the 100- and 500-year flood plain reaches (COE, 1976). For a 100-year flood event about 80% of LF-02 would be covered by 2-3 feet of water (Figure 2.8). This phenomenon is discussed in detail in Section 2.4.1, below.

The surface of the LF-02 area is generally well covered but litter is widespread and landfill debris are exposed in the Tijeras Arroyo channel on the south side (Figure 1.5). This landfill material does not show evidence of exposed potentially hazardous materials and appears to be composed of earth and inert materials (such as large cement blocks, boulders, tree stumps, etc.). Occasionally melted materials indicating burning are found although it cannot be determined if this burning occurred in situ or elsewhere.

The cover material was disturbed by grading and dredging in the northern and eastern portions of the site in response to localized ponding at LF-02 and included efforts to improve surface drainage by dredging (Glasgow, 1983, personal comm.). These activities have removed 3 to 5 feet of cover in places and created topographic depressions which typicaly support anomalously dense vegetation. Verification of the extent and location of ponding areas

during the Phase IIB field effort was impossible due to the lack of precipitation. Additionally, there are numerous "sink holes" and other soil collapse features on the surface of LF-02. These phenomena are attributable to shallow subsurface water flow or "piping" in combination with fine grained, silty soil (easily eroded) and poor compaction. These features will contribute to excessive infiltration of surface waters into the LF-02 fill materials.

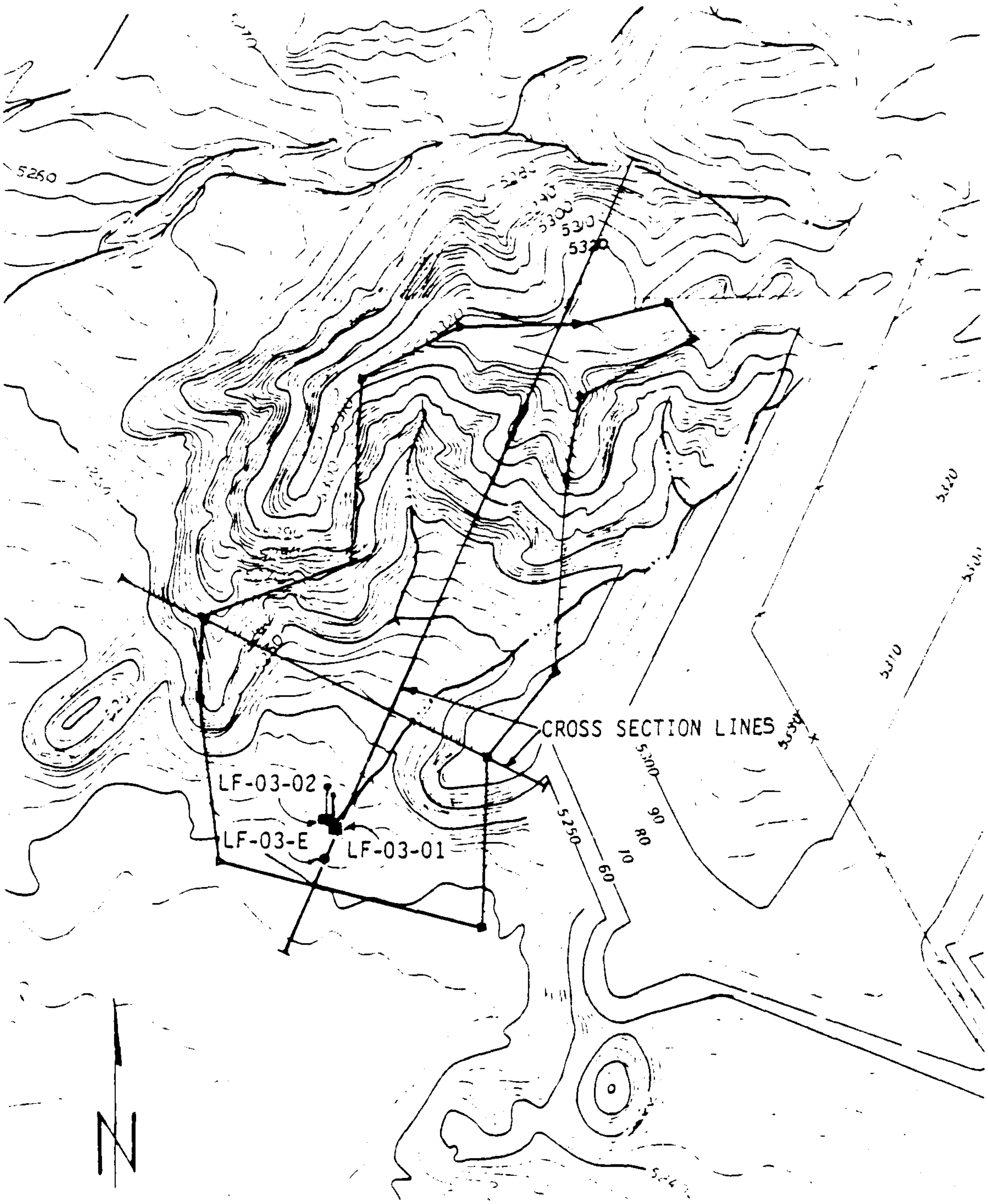
1.2.3 Landfill Number 3 (LF-03)

LF-03 is located in the SW sec. 6, T.9 N, R.4 E. LF-03 is bounded on the north, east and west sides by relics of natural ridges that define an arroyo which was filled to create the landfill. The southern boundary is taken at the change in slope between the gently sloping surface of the Tijeras Arroyo flood plain and the steep slopes that make up the Santa Fe Formation and the landfill cover material (Figure 1.8). Ground elevations at LF-03 range from 5231 feet, MSL at the southern extremity to 5330 feet, MSL at the northern extremity. LF-03 is above the Tijeras Arroyo flood plain and no surface drainages cross the site. Tijeras Arroyo is approximately 400 feet south of LF-03. Plate I shows the site relative to regional features and Figure 1.9 shows the details of the site with pre-landfill topographic control. No topographic control exists for the present conditions.

Documentation concerning the nature or quantity of the buried materials or period of operation was not found during the course of Phase II B investigations for LF-03. This landfill was created during the early 1970's in response to construction requirements of the TRESTLE Facility and is reported to consist largely of burned aircraft parts (Glasgow, 1983 personal communication). Aerial imagery (Molzen-Corbin, 1977)shows that operations at LF-03 had ceased by 1977.

The depth to the water table in the LF-03 area is about 380 feet which corresponds to an elevation of 4900 ft, MSL. The hydraulic gradient is to the north at about 10 feet per mile. KAFB production well #4 is located about 2400 feet north of LF-03. No ground water monitoring wells were drilled on this site (Figure 1.10).

Figure 1.8 Landfill No. 3 (LF-03)



Basemap: KAFB/CES, 1976

SCALE

200 100 0 200 400 ft.

Contour Interval = 2 ft.

LEGEND

SEE FIGURE 1.21

Figure 1.9 Landfill No. 3 (LF-03) Topographic Map

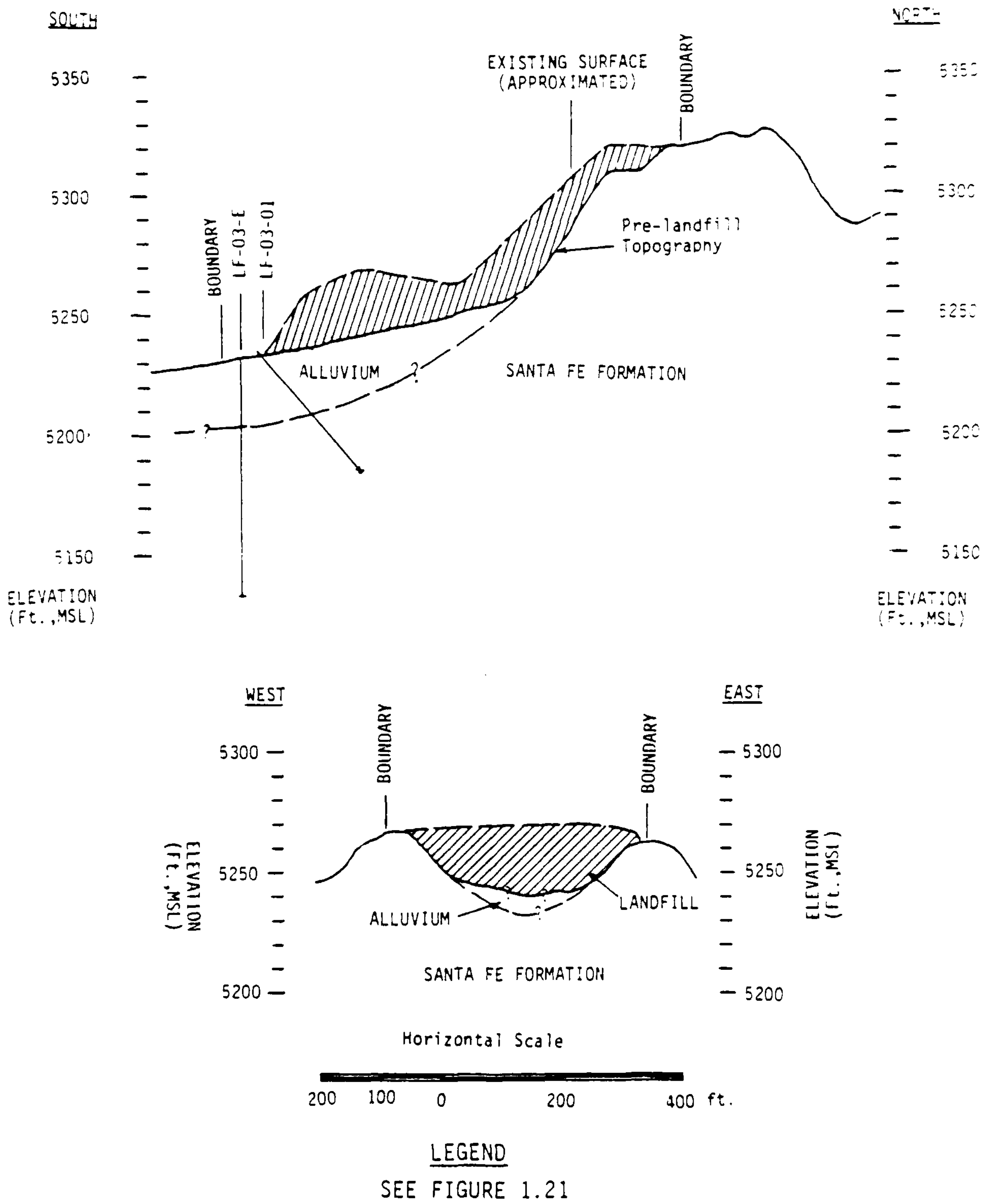


Figure 1.10 Landfill No. 3 (LF-03) Cross Sections

1.2.4 Landfill Number 4 (LF-04)

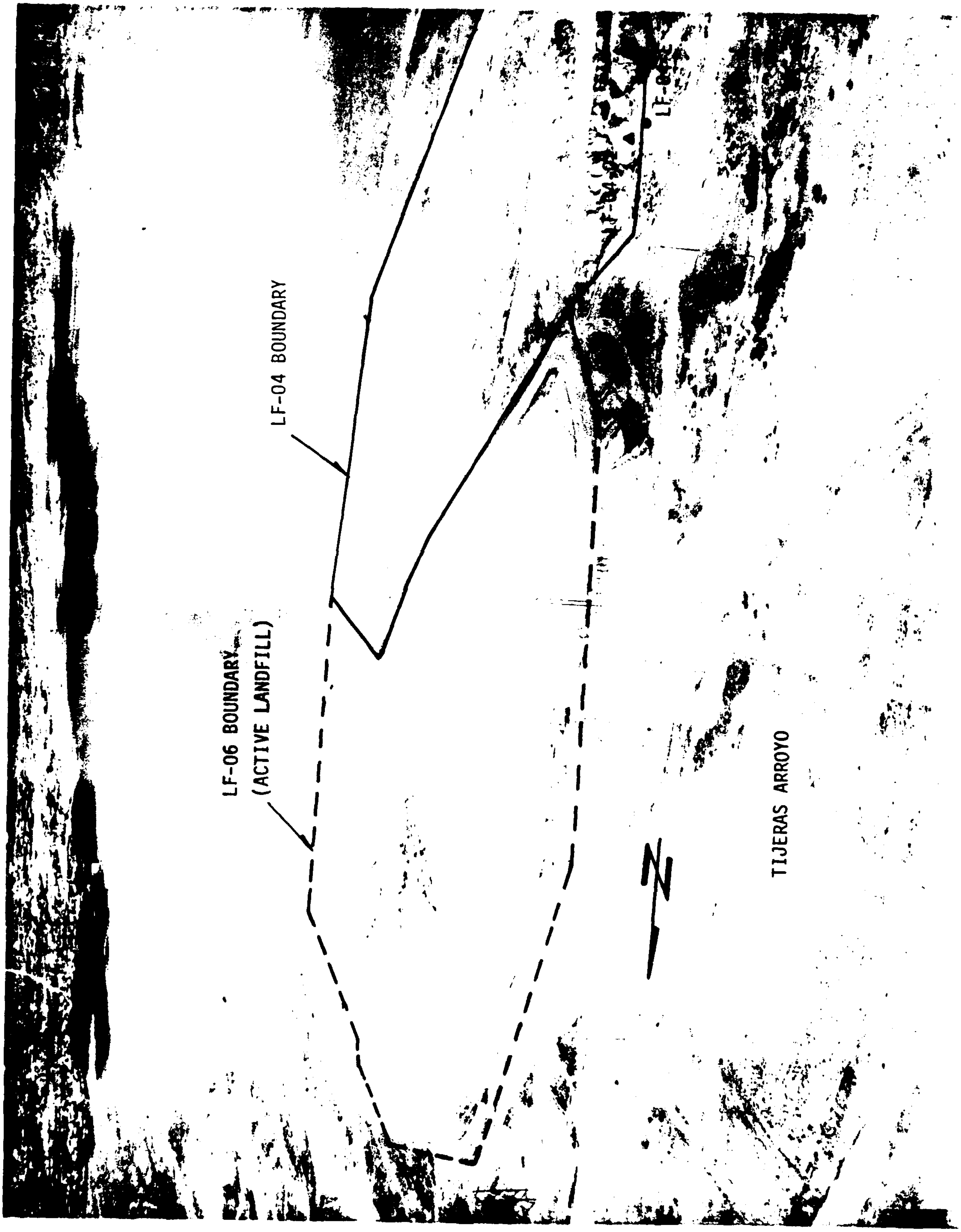
LF-04 is located in the SW sec. 4, T.9 N., R.4 E. and is bounded to the north by an active landfill operated by Kirtland AFB (LF-06) and to the south by a drainage berm. The eastern boundary of the landfill is an unpaved road and the western boundary is the covered slope of the landfill about 150 feet east of Powerline Road. Ground elevations range from 5350 feet, MSL at the western end (at the toe of the face) to 5435 feet, MSL at the northeastern corner. No surface drainages cross the site. The active channel of Tijeras Arroyo is about 1200 feet west of the landfill. Plate I shows LF-04 relative to regional features and Figure 1.12 shows the details of LF-04 with the best available topographic control. The area designated as "HARDFILL" was filled and covered after the topographic map was made.

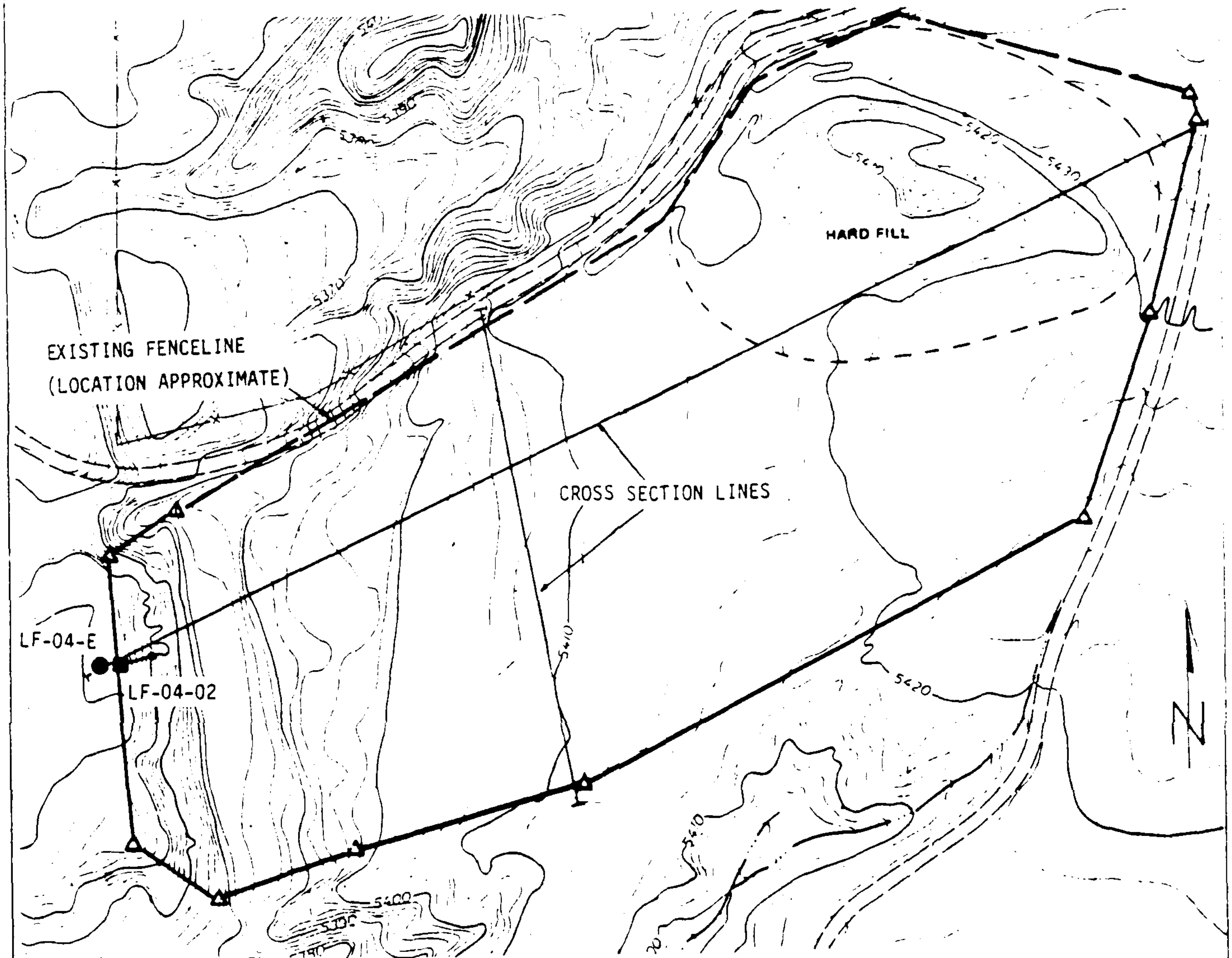
The depth to the water table in the vicinity of LF-04 has been estimated to be 500 feet, which corresponds to an elevation of about 4897 feet, MSL. The hydraulic gradient is estimated to be to the north-northwest at about 20 feet per mile (figure 1.13). KAFB production well #11 is located 3000 feet northwest of LF-04.

LF-04 was jointly operated by the City of Albuquerque and Kirtland AFB from 1964 to 1969. ESI (1981) has reported that the materials buried were general refuse. Aerial photographs and KAFB documents indicate a two-part plan of operation. "Hardfill" was placed in the northeastern part of LF-04 and general refuse was placed in two natural arroyos in the western part of LF-04. No documentation as to the nature of the refuse or hardfill was found during the course of this investigation.

Although the LF-04 site is generally well covered, there are topographic depressions on its surface that are causing accumulation and channeling of precipitation which is causing erosion of the cover material on the western face of the landfill (Figure 1.11). The unnamed drainage east of LF-04 (Figure 2.7) serves to reduce the impact of localized precipitation by channeling surface flow away from the landfill.

Figure 1.11 Landfill NO. 4 (LF-04)





Basemap: KAFB/CES, 1976

SCALE

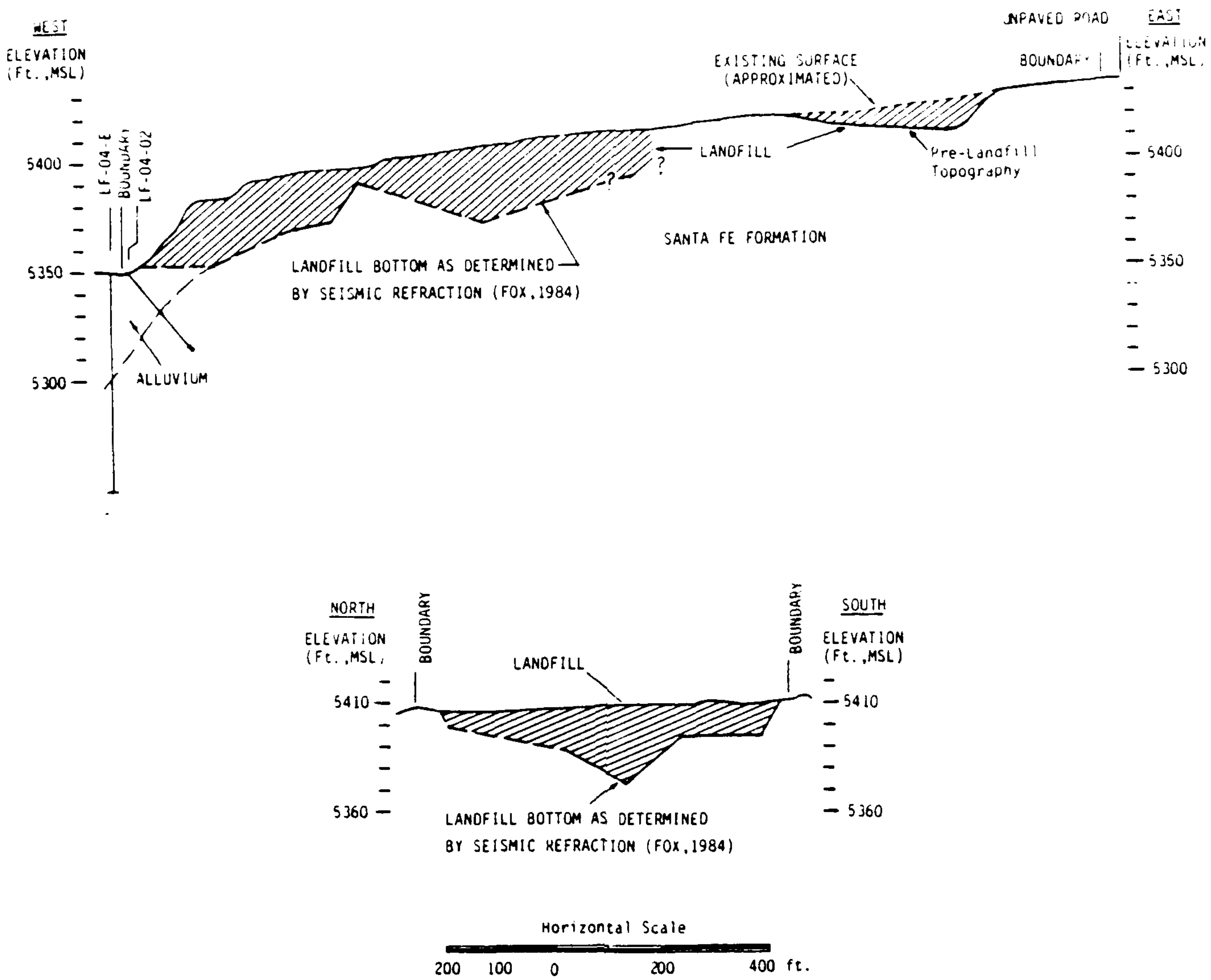
200 0 200 400 ft.

Contour Interval = 2 ft.

LEGEND

SEE FIGURE 1.21

Figure 1.12 Landfill No. 4 (LF-04) Topographic Map



LEGEND

SEE FIGURE 1.21

Figure 1.13 Landfill No. 4 (LF-04) Cross Sections

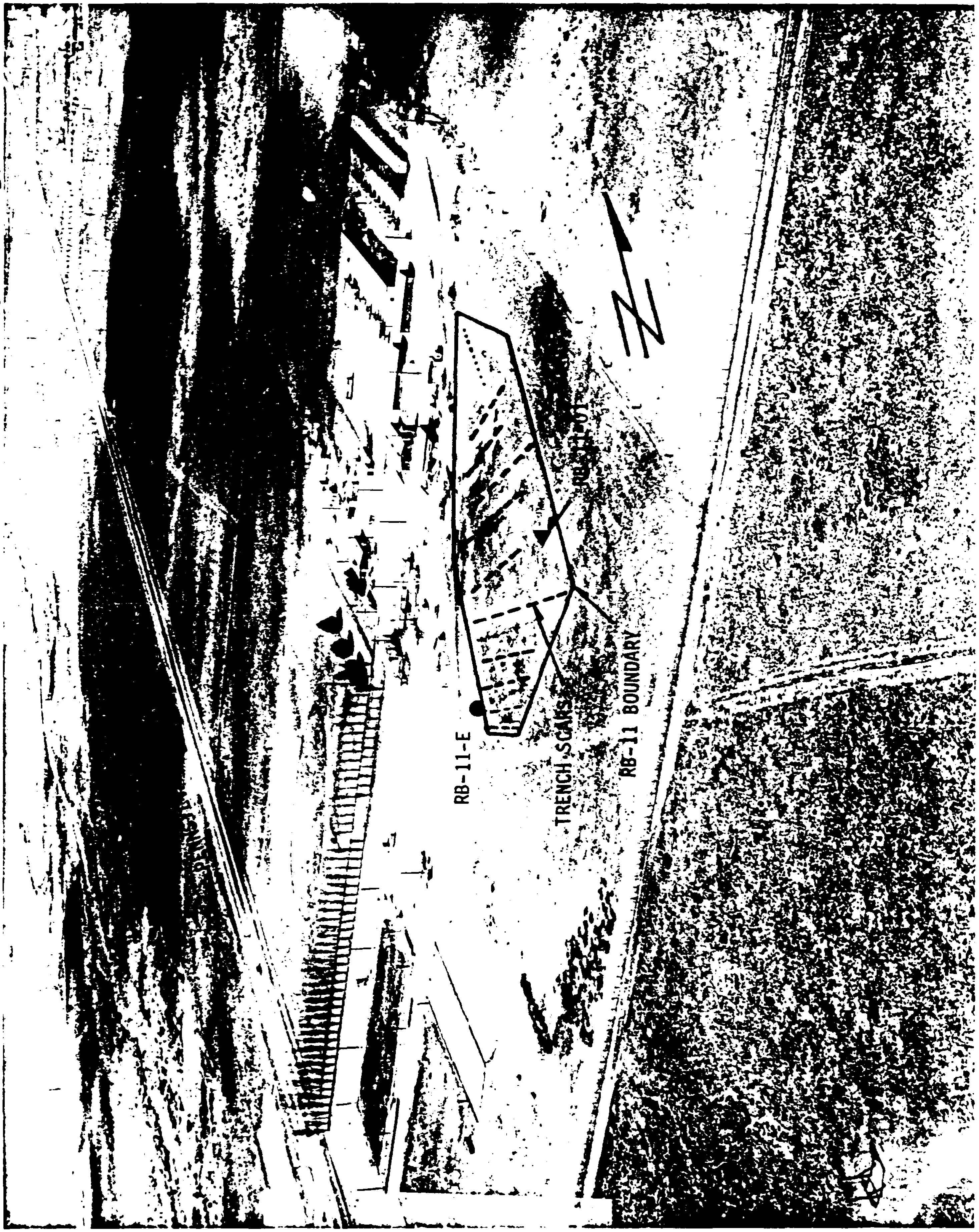
1.2.5 Radioactive Burial Site Number 11 (RB-11)

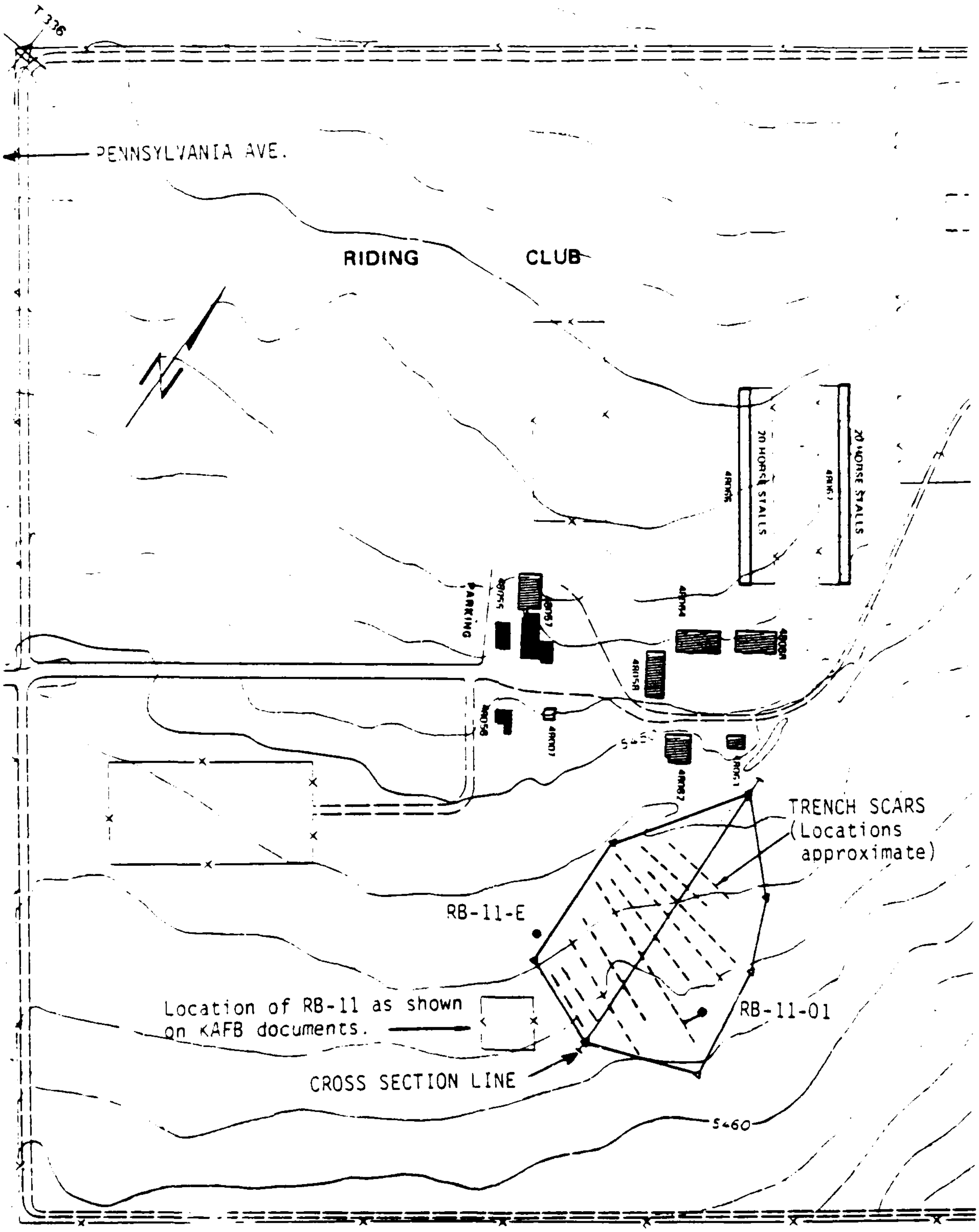
RB-11 is located in the NE sec. 16, T.9 N., R.4 E. This site is located entirely within the southeast quadrant of the Riding Club area. The RB-11 site has no outstanding physiographic features and the sole expression of burial activities are trenching scars which show depleted vegetation. A small area in the southwest corner of the site has been designated as a burial site with signs posted and an asphalt cap covering two trenches. This existing designation does not adequately encompass all of the burial trenches and is incorrectly located on several existing KAFB maps. The site is relatively flat with elevations ranging from 5451 feet to 5459 feet, MSL. The RB-11 site is not crossed by surface drainages. Arroyo del Coyote lies about 1400 feet southwest of RB-11. Plate I shows the RB-11 site relative to regional features and Figure 1.15 shows the details of the disposal site with the best available topographic control.

The depth to the water table in the vicinity of RB-11 is estimated to be 500 feet or more. The hydraulic gradient is to the northwest at about 25 feet per mile. KAFB well #9 (abandoned) is located about 2000 feet east-southeast of RB-11 and had a reported initial water level of 550 ft, BGS (KAFB Records).

Aerial image analysis indicates there are at least nine trenches at the RB-11 site (Figure 1.14). Dr. DeBoer, who is presently the USAF Weapons Laboratory Environmental Coordinator, (1983, personal communication) indicated that these trenches were covered with as much as eight feet of earthen fill (figure 1.16) and that all trenching operations were conducted on an as-needed basis from about 1960 to 1971. The quantity and nature of waste materials, as reported by ESI (1981) were confirmed by Dr. DeBoer.

Figure 1.14 Radioactive Burial Site No. 11 (RB-11)





Basemap: KAFB/CES, 1976

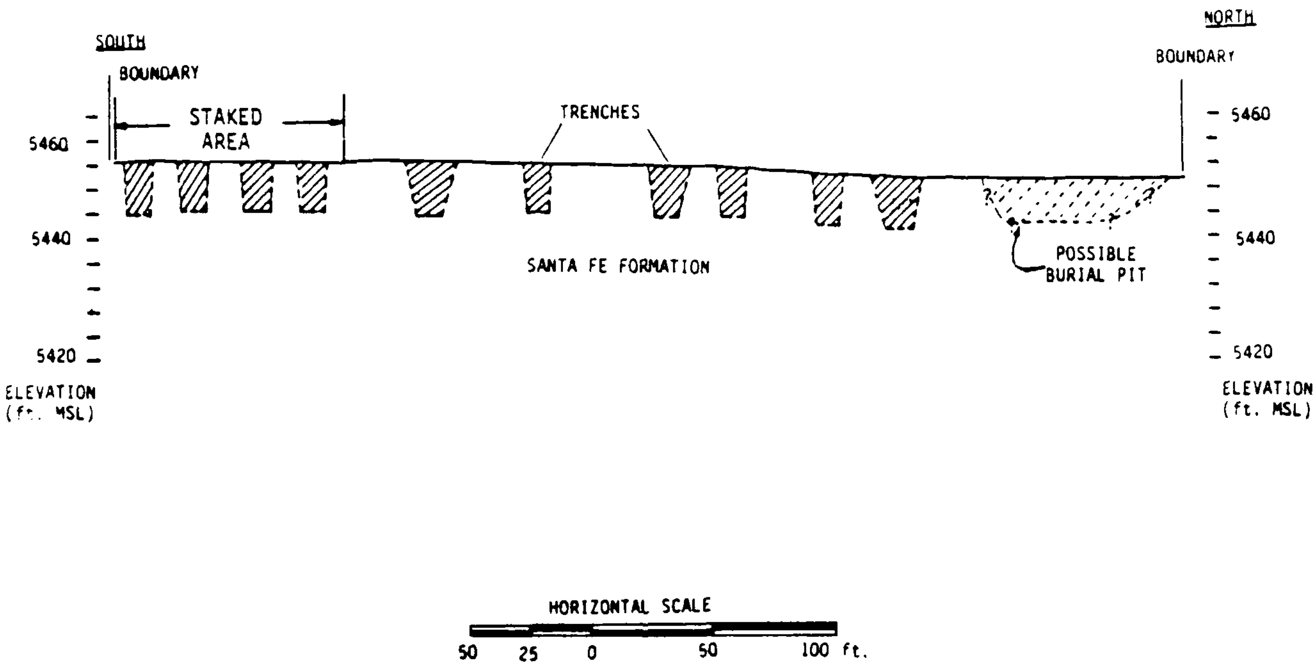
SCALE

200 0 200 400 ft.

LEGEND

SEE FIGURE 1.21

Figure 1.15 Radioactive Burial Site No. 11 (RB-11) Topographic Map



LEGEND

SEE FIGURE 1.21

Figure 1.16 Radioactive Burial Site No. 11 (RB-11) Cross Sections

ESI (1981) has given an accounting of the history and nature of the RB-11 operations on pages 4-41 and 4-42 of their Phase I report:

> The radioactive wastes consisted primarily of animal carcasses which had received doses of radioactivity, animal excreta, and contaminated solid wastes. Most of the radioactivity is in the form of induced activity and short half-lived elements, but it is likely that several millicuries of elements with longer half- lives may be present. It is estmated that the following numbers of animals were disposed of at the site: sheep, 1000 to 1500; burros, 60 to 75; goats, 40 to 50; chickens, 100 to 120 rats, 500-1000; cows, 4 to 10; and dogs, 40 to 60. Some of the waste was buried in drums, and some was not. An undetermined amount of liquid waste was also disposed of, along with small amounts of hazardous and toxic chemicals, including acids, mercury, cyanides, and silver.

Dr. DeBoer also confirmed the existance of a 55-gallon drum of mercury which was reportedly buried at the RB-11 site. His recollection of the event is vivid as the transport vehicle was physically distorted by the great wieght and there were problems with unloading the drum.

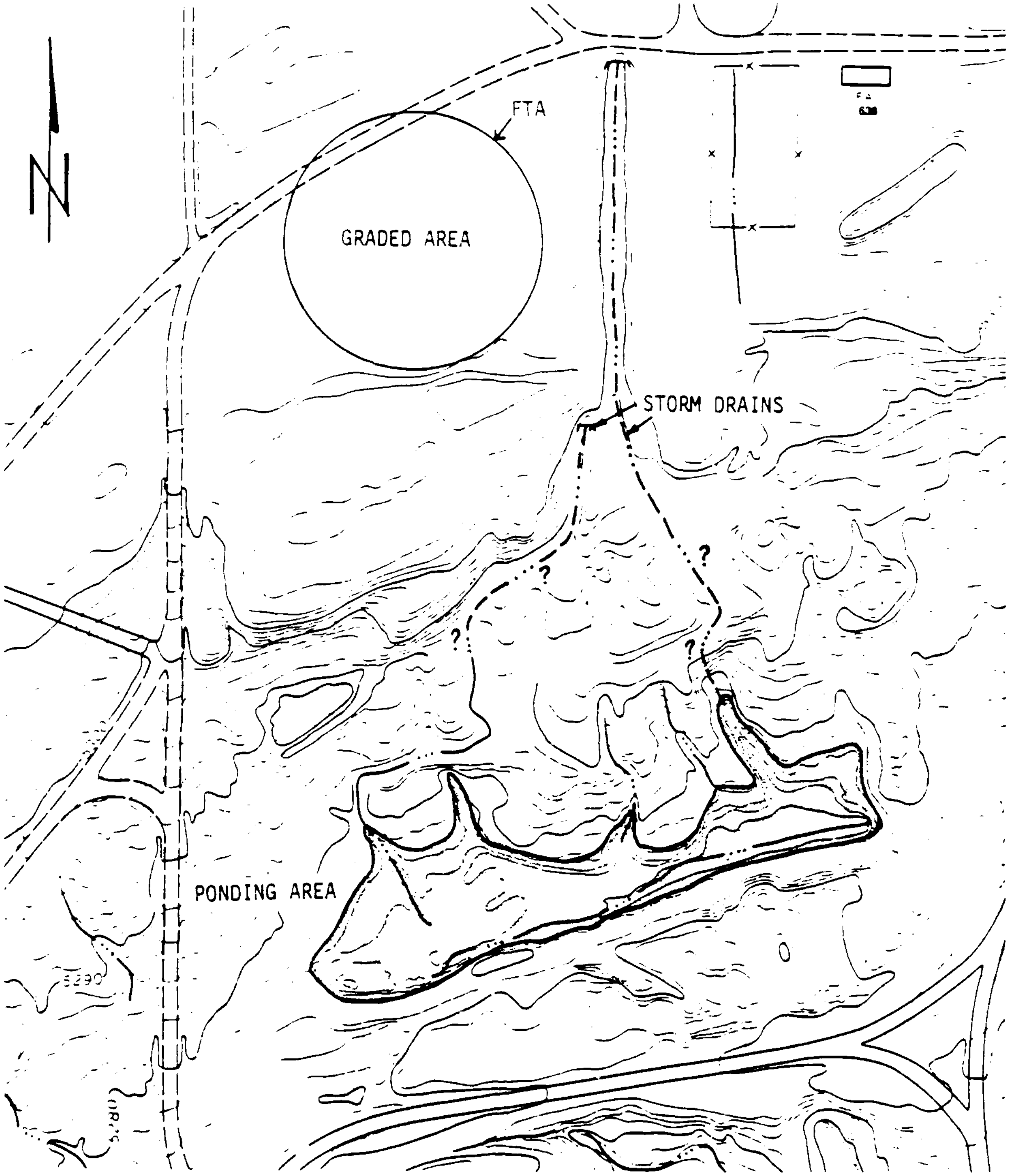
1.2.6 Fire Control Training Area (FTA)

The FTA is located in the NW sec. 2, T.9 N., R.3 E. This site is defined by a graded area with a radius of about 200 feet and lies about 600 feet southwest of the FAA Control Tower. The elevation of the FTA is about 5313 feet, MSL (Figure 1.20). Figure 1.18 shows the FTA and vicinity with the best available topographic control and Figure 1.19 shows the major features of the FTA. The steep slopes southwest of the FTA pad are made of asphaltic hardfill. This asphaltic material was not encountered during drilling and sampling efforts.

The depth to the water table in the vicinity of the FTA is 400 feet (4895 ft, MSL). The hydraulic gradient is to the north at 6 to 7 feet per mile. There are no water supply wells within one mile of the FTA site.

In the center of the graded area is a steel mock-up of an aircraft on a circular cement pad which is about 65 feet in diameter (Figure 1.17). A fuel storage tank is located southeast of the graded area and feeds a sprinkler system under the pad during training exercises. After an exercise, residual liquids (JP-4 and, AFFF Foam and water) are allowed to evaporate. A drain system extends from the east side of the pad to the open storm drain 300 feet

Figure 1.17 Fire Control Training Area (FTA)



Basemap: KAFB/ CES, 1976

SCALE

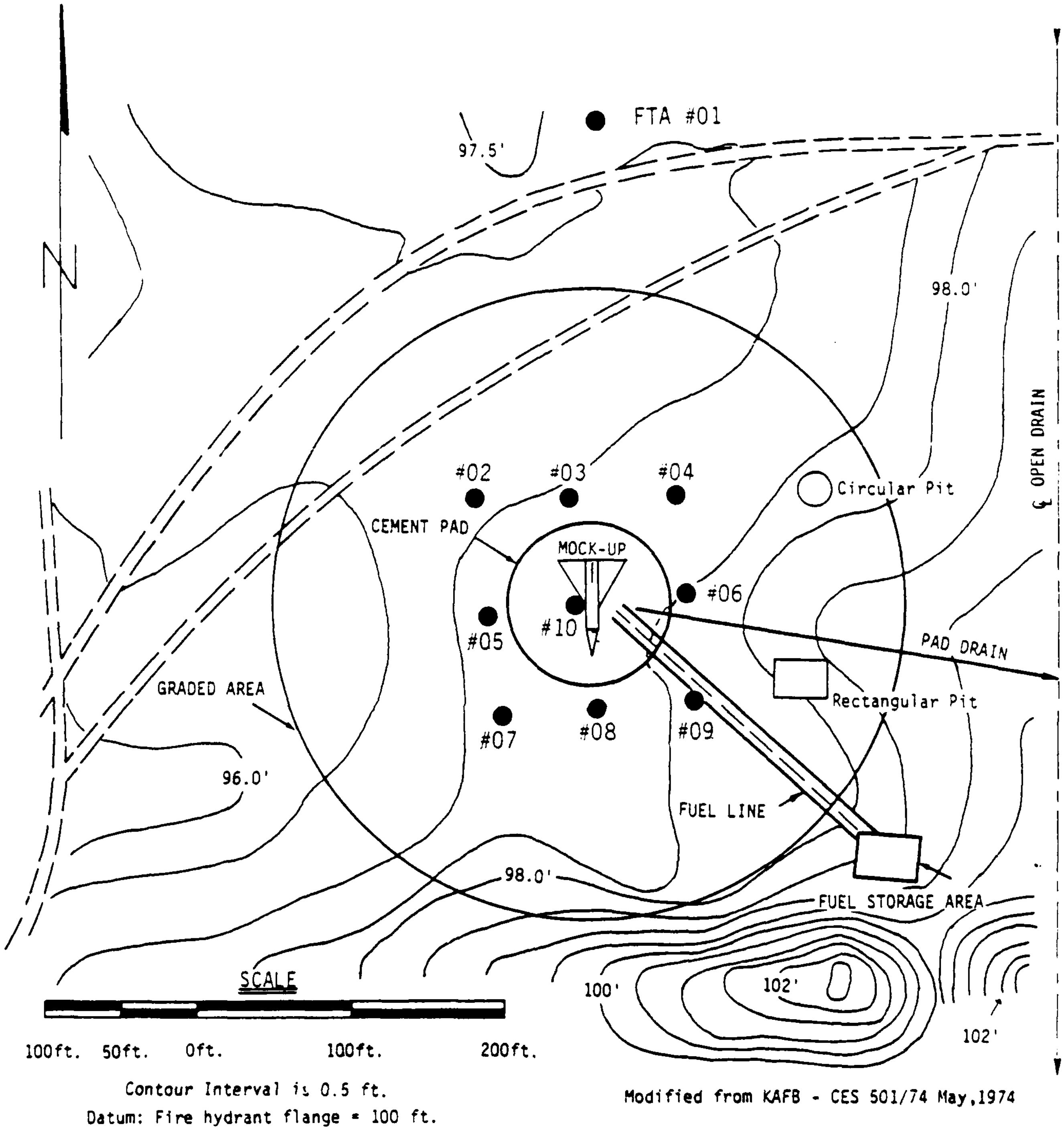
200 100 0 200 400 ft.

Contour Interval = 2 ft.

LEGEND

SEE FIGURE 1.21

Figure 1.18 Fire Control Training Area (FTA) Topographic Map



LEGEND

SEE FIGURE 1.21

Figure 1.19 Fire Control Training Area (FTA) Detailed Site Map

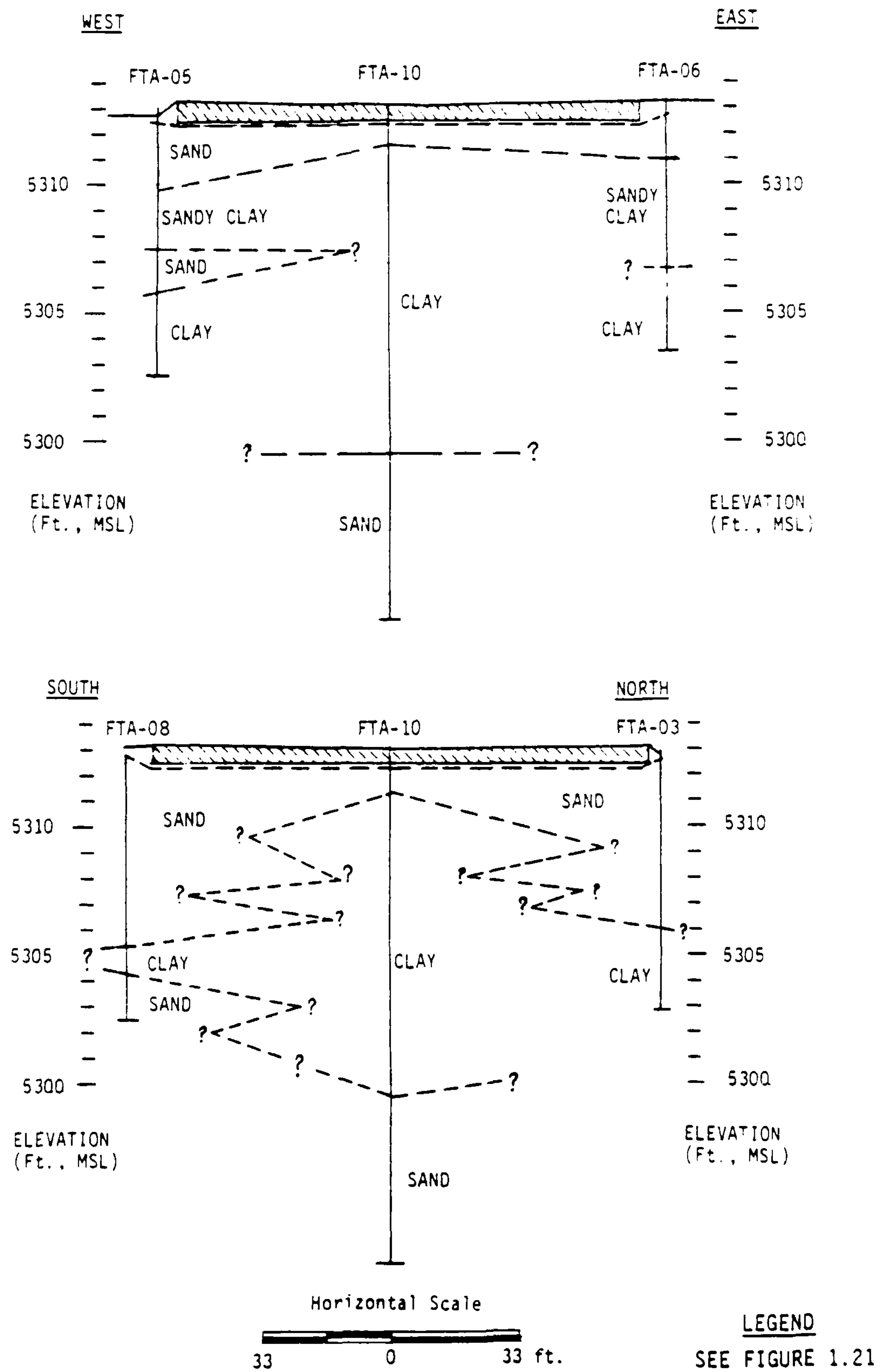


Figure 1.20 Fire Control Training Area (FTA) Cross Sections

LEGEND

Topographic Maps

Roads

Road (unimproved)

Fence

Railroad

Drainage channel

5460 Index contour

Intermediate contour

Depression contour

Landfill boundary

DM-01 LF-01-E Vertical boreholes drilled during Phase IIB
"DM-" denotes ground water monitoring well
"-E" denotes 100-foot exploratory borehole
"FTA-" denotes 10- or 20-foot FTA borehole

Vertical borehole drilled by Molzen-Corbin, 1977 (solid star denotes fill materials encountered- see Appendix E)

LF-01-01 Slant lysimeter - box denotes surface access point, bar shows bearing and ball shows sampling point. All slant borings drilled at 45° to 50° from horizontal.

Surface water ponding area

Cross Sections

Vertical borehole

LF-01-01 Slant lysimeter

Landfill or trench materials - depths are 20% as determined by seismic refraction. Limits are dashed where inferred and queried where data are lacking.

Alluvium / Santa Fe Fm. Geologic contact - inferred, queried where lacking data.

Buried pipeline

Figure 1.21 Legend for Topographic Maps and Cross Sections

away. Wozniak (1983, personal communication) indicated that the drain had not been used during his assignment to Kirtland AFB.

In addition to the mock-up pad, there are two features in the graded area that have been used in the past for training exercises. These areas are designated as the "rectangular pit" and the "circular pit" on Figure 1.19. Wozniak (1983, personal communication) indicated that flammable materials of varied and unknown composition were placed in the pits and ignited to simulate structural fire conditions. They have since been filled with soil and were not investigated.

About 50 feet east of the eastern edge of the graded area are two storm drains. These drains service the runway and other developed areas to the north (see Figure 2.7). The eastern-most drain discharges into the open ditch to the east of the FTA site. The other drain is buried as it passes the eastern edge of the FTA site and discharges into a poorly drained area to the southeast of the pad area. This poorly drained area receives water from both drain lines and supports anomalously dense vegetation. Petroliferous residue was observed in residual fluids at the buried drain's point of discharge. The existing vegetation does not appear to have been adversely affected by these discharges.

1.3 POLLUTANTS SAMPLED

The geochemical sampling performed at KAFB addressed the analyte schedules indicated below:

Fire Control Training Area

A total of 30 soil samples were analyzed for oil and grease and Total Organic Halogens (TOX-consisting of a scan for total organic bromide, total organic chloride and total organic iodide)

Monitor Wells Dm-01 and DM-02

One water sample from each was analyzed for Total Organic Carbon (TOC), TOX and nitrate as N.

Lysimeters

A total of 7 soil samples, representative of the lysimeter intake area, were analyzed for oil and grease, TOX, total lead, total sodium, total iron, and a pesticide scan (consisting of 2,4-D, 2, 4,5-T, DDT, DDE, DDD, dieldrin, aldrin, lindane, methoxychlor, and heptachlor epoxide). Total silver and total mercury analyses were performed on the RB-11 sample only. Attempts to acquire liquid samples via the lysimeters were unsuccessful.

The boreholes drilled at the RB-11 site were to have undergone insitu radiological borehole logging by KAFB personnel with a down-hole gamma probe. This probe was non-functional at the time of drilling and consequently, radiological monitoring was performed on cuttings as they reached the surface by members of KAFB Hospital Radiological Health Section (SGPBR). Measurements were made with hand-held, low energy, gamma- and X-ray detectors. No readings above background were recorded (see Appendix E).

1.4 *FIELD TEAM*

The Phase IIB field efforts were performed by the organizations and key personnel indicated below:

Kirtland AFB
- Capt. Robert Senchy - AF liason
- Lt. Col. Steven Robinson - AF liason

Science Applications, Inc. (SAI)
- Clay Culver - Geologist*
- Stuart Faith - Environmental Engineer*

FM Fox and Associates
- Steven Brewer - Geologist
- David Tanner - Driller

Rodgers and Company (DM-01 and DM-02 only)
- Bert Robison - Driller

Scanlon and Associates
- Thomas Wagner - Survey Crew Chief

*Resume presented in Appendix C.

2.0 ENVIRONMENTAL SETTING

The Phase I report prepared by ESI presented a generalized environmental setting discussion in Section 3. An augmentation of that discussion follows.

2.1 METEOROLOGY

The climate of Kirtland AFB and vicinity is classified as "arid continental" (NOAA, 1981). The mean annual precipitation is 8.4 inches with a mean annual snowfall of 1.25 inches (at Albuquerque International Airport). The potential evaporation for the Albuquerque area is 30.9 inches (ESI, 1981, p. 3-1). The average monthly precipitation in the Albuquerque area varies from less than one (1) inch (November through March) to over one and one-quarter (1.25) inches in July and August. The winter months are typically dry with monthly snowfalls seldom exceeding three (3) inches. Snow rarely lasts longer than 24 hrs. in the non-mountainous areas. Typically, the summer months receive almost half of the annual moisture in the form of brief but locally heavy thunderstorms. Prolonged periods of continuous precipitation are very rare (NOAA, 1981).

2.2 PHYSIOGRAPHY

Kirtland AFB is located in the Rio Grande Valley of the Mexican Highland Subdivision of the Basin and Range Physiographic Province. The Rio Grande Valley is a depressed linear feature extending from its headwaters in the central Rocky Mountains in southern Colorado, through New Mexico and Texas to the western edge of the Gulf of Mexico. In the Albuquerque area, the North trending Rio Grande Valley is bounded to the east by the Sandia Mountains (northeast of KAFB) and the Manzano Mountains (east and south of KAFB). These mountains form north-trending, west-facing scarps that rise over 5000 feet above the valley floor. The western margin of the Rio Grande Valley is less pronounced where the topographic boundary of the Rio Grande Valley is the east edge of Ceja Mesa and the physiographic subdivision boundary located west of the Rio Puerco (about 12 miles further west). Plate I shows selected regional features relative to Kirtland AFB and Phase IIB study sites.

Lambert (1968) divided the Rio Grande Valley in the Albuquerque area into six physiographic subdivisions. Kirtland AFB occupies two of these physiographic subdivisions: (1) the west front of the Sandia and Manzano Mountains, and (2) the Sandia-Manzano piedmont plain between the mountains and the inner valley of the Rio Grande (Lambert, 1968). The piedmont surface ranges in altitude from 6,000 ft at the mountain front, to 5,000 ft at the steep scarp on the eastern edge of the inner valley. The gradient of the piedmont surface averages about 70 feet per mile to the west, but tapers to about 15 feet per mile to the west and locally dips to the east.

On KAFB, the Sandia-Manzano Piedmont plain is dissected by two natural channels, Tijeras Arroyo and Arroyo del Coyote (Plate I). Tijeras Arroyo is a west-trending ephemeral stream that has incised a steep-sided, flat-bottomed channel (arroyo) about 100 to 130 feet deep and 1/4 to 1/2 mile wide. Tijeras Arroyo drains a large area of about 150 square miles of the southern Sandia and northern Manzano Mountains which is above its confluence with the south ditch of the Albuqueruqe Metropolitan Arroyo Flood Control Authority. Arroyo del Coyote starts on the west flank of the Manzano Mountains, bends around the southwest corner of the Manzanitas (KAFB-Manzano Area), and trends north-northwest to a confluence with Tijeras Arroyo at the Pennsylavania Street bridge. Arroyo del Coyote drains an area of about 30 square miles on the west face of the Manzano Mountains and occupies a channel which is about 100 to 400 feet wide and about 4 to 20 feet deep. There are several springs located along the course of Arroyo del Coyote east of the Travertine Hills but their discharge seeps into the channel a short distance from the springs. More detailed discussions of KAFB surface drainages are presented in Section 2.4.

The Sandia-Manzano Piedmont plain extends two to four miles west of KAFB lands where it gives way to the inner valley of the Rio Grande. The inner valley area west of KAFB and south of Central Avenue is locally known as the South Valley.

2.3 REGIONAL GEOLOGY

The geology of the Albuquerque area has been reported by several authors including Bjorklund and Maxwell (1961), Lambert (1968), Kelley (1968, 1974, 1977), and Grant (1982). A review of their works as well as others was

presented in the ESI Phase I report. The following discussion will emphasize geologic conditions relative to the Phase II waste disposal sites.

Figure 2.1 summarizes the surficial geology of the central KAFB area near LF-04 and RB-11. This map shows the complex geologic structures that characterize the KAFB area and subsequent impact on the analyses of the RB-11 area. Figure 2.1 has placed all unconsolidated sedimentary material under "Qal", or Alluvium. This report subdivides this unit into the Santa Fe Formation and floodplain alluvium. The surficial geology of the area immediately west of Figure 2.1 consists of the various members of the Santa Fe Formation and alluvial deposits. Phase IIB is largely concerned with those parts of the Santa Fe Formation which are above the water table and the alluvium deposits, both of which are described below.

2.3.1 Stratigraphy

The geologic units in the Albuquerque area range in age from Precambrian (1.5 billion years old) to Recent and consist of sedimentary rocks, igneous rock, metamorphic rocks, and unconsolidated materials. Within the boundaries of Kirtland AFB there are complex associations of Precambrian crystalline rocks in the eastern, mountainous areas (Kirtland East), Tertiary and Quaternary unconsolidated and semi-consolidated pediment deposits west of the Manzano area, Tertiary (?) travertine deposits in the southwest corner of the Manzano Area and east of DOE Area III, and Recent Aeolian and stream channel deposits located throughout the study area. These units are described in Table 2.1.

The dominant surficial geologic units for each IRP study area are listed below:

- Recent Deposits (LF02)
- Ortiz Gravel (RB-11, LF04, FTA)
- Santa Fe Formation (LF01, LF03, LF04, FTA)

The recent deposits include flood plain alluvium, Aeolian (wind-blown) sands, and lacustrine (lake) deposits. The flood plain alluvium is pertinent to the analysis of (LF-02) which is located in the alluvium of Tijeras Arroyo

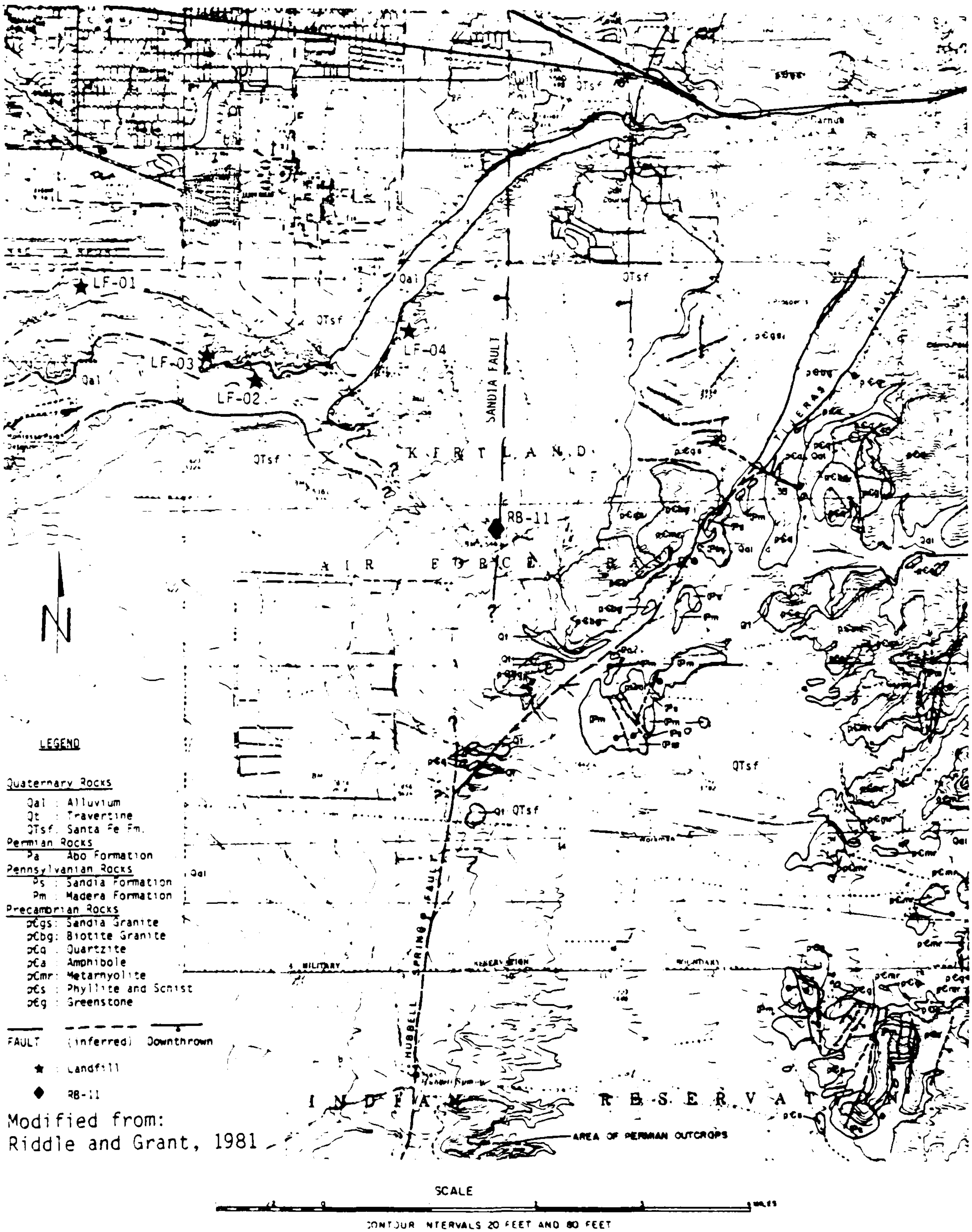


Figure 2.1 Geologic Map of Kirtland AFB and Vicinity

Table 2.1 Geologic Formations in the Albuquerque-Kirtland AFB Area

ERA	SYSTEM	SERIES	UNIT	THICKNESS (FEET)	LITHOLOGY	WATER-BEARING CHARACTERISTICS
CENOZOIC	QUATERNARY	RECENT	ALUVIUM	0 TO 120±	COBBLES, GRAVEL, SAND, SILT, AND CLAY; UNCONSOLIDATED. GENERALLY UNDERLIES VALLEY FLOOR.	YIELDS LARGE QUANTITIES OF WATER OF GOOD TO FAIR QUALITY TO IRRIGATION, INDUSTRIAL, STOCK, AND DOMESTIC WELLS. WATER GENERALLY HAS A HIGH SILICA CONTENT
			BAJADA DEPOSITS	0 TO 200±	BOULDERS, COBBLES, GRAVEL, SAND, AND SILT, CONSISTING OF FRAGMENTS OF FELDSPAR, QUARTZ, AND IGNEOUS AND METAMORPHIC ROCKS, UNCONSOLIDATED TO LOOSELY CONSOLIDATED.	GENERALLY LIE ABOVE THE WATER TABLE EXCEPT ALONG THE MOUNTAIN FRONT AT THE CONTACT WITH PRE-TERTIARY ROCKS. YIELD SOME WATER TO CONTACT SPRINGS AND MAY YIELD WATER TO A FEW DOMESTIC AND STOCK WELLS.
		PLEISTOCENE (?)	SANTA FE GROUP	0 TO 6,100+	BOULDERS, COBBLES, GRAVEL, SAND, SILT, AND CLAY, UNCONSOLIDATED TO CONSOLIDATED BUT GENERALLY WEAKLY CEMENTED. INCLUDES INTERBEDDED VOLCANIC MATERIAL LOCALLY.	YIELDS LARGE QUANTITIES OF WATER OF GOOD QUALITY TO MUNICIPAL, INDUSTRIAL, IRRIGATION, STOCK, AND DOMESTIC WELLS. WATER GENERALLY HAS A HIGH SILICA CONTENT.
	TERTIARY	MIOCENE (?)				
		EOCENE	ESPINASO VOLCANIC ROCKS OF STEARNS (1943)	400 TO 1,400	BRECCIA, CONGLOMERATE, AND TUFF	DEEPLY BURIED IF PRESENT; NO WELLS ARE KNOWN TO BE COMPLETED IN THIS FORMATION.
		EOCENE AND OLIGOCENE (?)	GALISTEO FORMATION	900 TO 4,000	SANDSTONE, SAND, CLAY, AND SHALE	DO.
MESOZOIC	CRETACEOUS	UPPER	MESAVERDE GROUP	1,500 TO 2,000	PREDOMINANTLY GRAY TO BLACK SHALE. INCLUDES SEVERAL PROMINENT BEDS OF BUFF-COLORED TO GRAY SANDSTONE AND SOME THIN BEDS OF COAL.	NO WELLS TAP THIS UNIT BECAUSE OF GREAT DEPTH. SANDSTONE BEDS YIELD WATER OF FAIR TO POOR QUALITY TO STOCK AND DOMESTIC WELLS IN ADJOINING AREAS.
			MANCOS SHALE	900 TO 2,500	PREDOMINENTLY GRAY TO BLACK SHALE; INCLUDES SEVERAL BEDS OF BUFF-COLORED TO GRAY SANDSTONE.	DO.
		LOWER	DAKOTA SANDSTONE	75 TO 110	SANDSTONE, BUFF TO TAN; INTERBEDDED SHALE.	DO.
	JURASSIC	UPPER	MORRISON FORMATION	210 TO 660	SHALE, GREEN, PINK, GRAY, AND MAROON, AND WHITE AND BUFF SANDSTONE MEMBERS.	DO.
			ZUNI SANDSTONE: BUFF SANDSTONE	100 TO 140	SANDSTONE, BUFF.	DO.
			SUMMERVILLE FORMATION	60 TO 120	SANDSTONE AND SANDY SHALE, RED TO GRAY.	DO.
			TODILTO LIMESTONE	40 TO 260	TWO BEDS OF LIMESTONE SEPARATED BY A THICK BED OF GYPSUM.	BURIED DEEPLY; YIELDS LITTLE OR NO WATER WATER HAS A HIGH SULFATE CONTENT.
			ENTRADA SANDSTONE	160 TO 220	SANDSTONE, CROSS-BEDDED, RED TO GRAY.	BURIED DEEPLY; YIELDS WATER TO STOCK AND DOMESTIC WELLS IN ADJOINING AREAS. QUALITY OF WATER GENERALLY POOR BECAUSE OF HIGH SULFATE CONCENTRATION.
	TRIASSIC	UPPER	CHINLE FORMATION	1,100	SHALE, RED, AND CHANNEL DEPOSITS OF SHALY SANDSTONE; CONTAINS BEDS OF RED SANDSTONE AT TOP AND BOTTOM.	BURIED DEEPLY; YIELDS NO WATER TO WELLS. SANDY ZONES YIELD WATER TO DOMESTIC AND STOCK WELLS IN ADJOINING AREAS. QUALITY OF WATER GENERALLY IS POOR.
PALEOZOIC	PERMIAN		SAN ANDRES LIMESTONE	47 TO 470	INTERBEDDED LIMESTONE, GYPSUM, AND SANDSTONE.	BURIED DEEPLY; YIELDS WATER TO STOCK AND DOMESTIC WELLS IN ADJOINING AREAS.
			GLORIETA SANDSTONE	70 TO 220	SANDSTONE, FINE-GRAINED, BUFF TO WHITE, CONTAINS GYPSUM IN SOME AREAS.	DO.
			YESO FORMATION	400 TO 1,100	SANDSTONE AND SILTSTONE, TAN-BROWN TO RED.	BURIED DEEPLY; YIELDS LITTLE OR NO WATER TO WELLS.
			ABO FORMATION	810 TO 660	SANDSTONE, FINE- TO COURSE-GRAINED, AND SILT STONE; RED TO GRAY.	BURIED DEEPLY; YIELDS SMALL QUANTITIES OF WATER TO STOCK WELLS IN ADJOINING AREAS.
	PENNSYLVANIAN		MADERA LIMESTONE	450 TO 2,000	LIMESTONE, GRAY TO RED; UPPER PART INCLUDES MORE CLASTIC MATERIAL THAN LOWER PART.	BURIED DEEPLY; ARKOSIC MEMBER YIELDS SMALL QUANTITIES OF WATER TO STOCK AND DOMESTIC WELLS IN ADJOINING AREAS.
			SANDIA FORMATION	0 TO 416	SANDSTONE, SHALE, AND LIMESTONE, BROWN, GRAY, RED, AND BLACK; UPPER PART GENERALLY CLASTIC MATERIAL, LOWER PART GENERALLY LIMESTONE.	BURIED DEEPLY; YIELDS SMALL QUANTITIES OF WATER TO STOCK AND DOMESTIC WELLS IN ADJOINING AREAS.
	PRECAMBRIAN			10,000+	METAMORPHIC AND IGNEOUS ROCKS.	SURFICIAL WEATHERED AND FRACTURED ZONES YIELD SMALL QUANTITIES OF WATER OF SPRINGS AND WELLS ALONG MOUNTAIN FRONT FOR STOCK AND DOMESTIC SUPPLIES.

From: Bjorklund and Maxwell (1961)

0.5 miles west of the Pennsylvania Avenue bridge. In the LF-02 area the flood plain deposits are predominantly mixtures of sandy silt and silty sand with minor amounts of clay, gravel, and larger sized material. These materials display a wide variety of depositional characteristics which are typical of a fluvial (river or stream) environment. Vertical continuty is determined by the rate and volume of flow in and around the channel and material changes vary from gradational to abrupt. Two types of deposits can be observed within the floodplain alluvium: the first is coarse grained (sand to cobble-sized), relatively young, and consistent with existing climatic conditions, and, the second is fine grained (clay-to gravel-sized) and underlies the coarser grained material. The fine grained material may reflect a moister climate than now exists in New Mexico.

The Ortiz (or Tuerto) gravel surface is an alluvial pediment sand and gravel deposit overlying the Santa Fe Formation at the RB-11 and LF-04 study sites. The Ortiz gravel was present at the FTA but has been removed by grading activities. This geologic unit has its type section in the Oritz Mountains of New Mexico and is correlated to the units in the KAFB area by similarity of altitude, attitude, maturity of development and thickness of related caliche. Distinguishing the Ortiz gravel from the underlying Santa Fe Formation is difficult due to the large amounts of gravel in the Santa Fe Formation and the masking effects of aeolian sands (Kelley, 1977). Previous authors have described the thickness of the Ortiz gravel as ranging from 5 to 10 feet thick on the western edge of the piedmont plain to over 100 feet thick near the mountain fronts (Kelley, 1977). Locations of the Ortiz gravel surface generally coincide with piedmont surfaces in the vicinity of KAFB. Of significance to the IRP investigation is the thickening of these coarse grained deposits along the eastern border of the Albuquerque-Belen basin. The coarse grained material, in conjunction with the change in topography, acts as recharge area for the ground water basin by enhancing the infiltration of runoff from the mountainous terrains. This unit was not separately mapped during this project and was considered as part of the Santa Fe Formation.

The Santa Fe Formation in the Albuquerque area has been informally subdivided into three members: the Zia or "lower gray", the "middle red" or "main body", and the Ceja or "upper buff" (Kues, Lucas and Ingersoll, 1982).

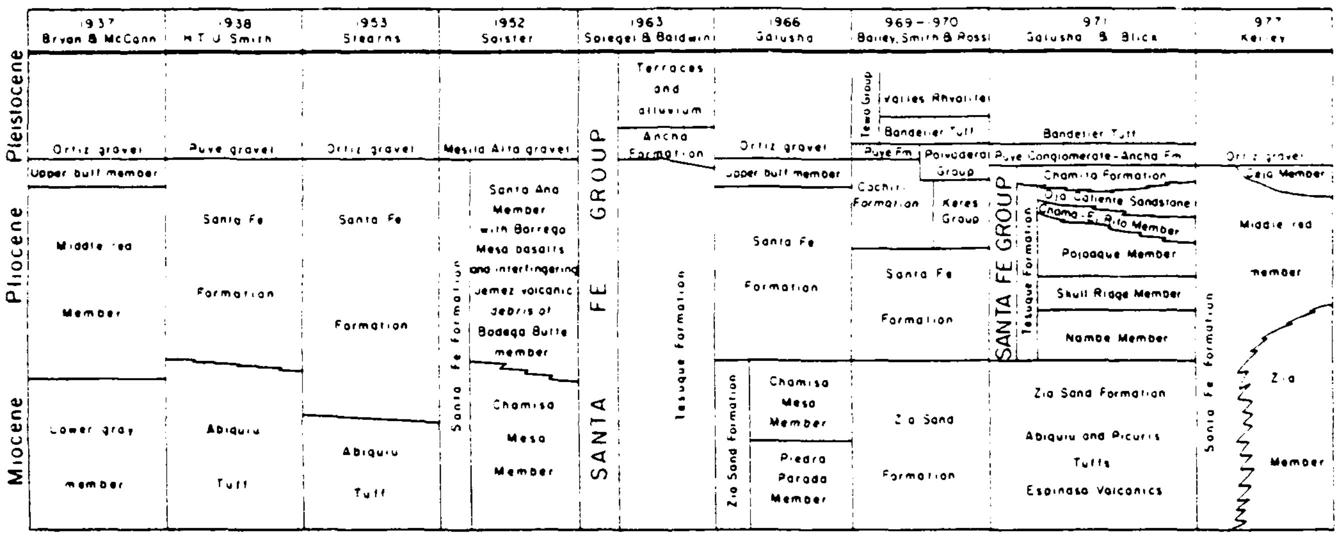
This informal subdivision has, however, not been universally accepted due to varying interpretations of the members' characteristics (Kelley, 1977, and Tedford, 1982). Table 2.2 illustrates various proposed subdivisions of the Santa Fe Formation. For purposes of this report, the divisions of the Santa Fe Formation as proposed by Kelley (1977) shall be used.

All of the IRP study areas are underlain by the Ceja Member of the Santa Fe Formation (Lambert, Hawley and Wells, 1982 and Kelley, 1977). The other geologic units shown in Table 2.1 are probably present under Kirtland AFB but are overlain by thick deposits of Santa Fe Formation and younger materials ranging from more than 500 feet thick in the vicinity of RB-11 (KAFB-Well #9) to over 3000 feet thick at the western edge of Kirtland AFB (Lambert, 1968). Figure 2.2 shows a generalized west to east cross section in the vicinity of Kirtland AFB modified from Lambert, (1968).

The Ceja Member consists of sandy gravel and gravelly sand interbedded with tabular to lenticular lenses of buff-colored clay, silt, and sand (Lambert, 1968) that range in thickness from less than 1 foot to more than 40 feet (Kelley, 1977). The Ceja Member ranges from about 300 to 500 feet under Kirtland AFB. The sandy gravels and gravelly sands typically grade into one another and are distinguished only by the percentage of pebbly gravel. Extremely rapid changes in grain size are seen in nearby outcrops and sorting ranges from poor to very poor. Weathered colors of the Ceja Member include yellowish gray (5Y 7/2) and very pale orange (10YR 8/2) (Lambert, 1968). Fresh sample colors are typically moderate yellow brown (10YR 5/4) to pale brown (10YR 6/2) (see Appendix E).

Figure 2.3 shows a spontaneous potential (SP) response and a suite of resistivity and conductivity responses from KAFB Well 11 located one-half mile northeast of LF-04 (see Plate 2). This set of logs, run in 1972, shows the Santa Fe Formation as being composed of sandy silts and silty sands with numerous thin (less than 10 feet thick) beds of very sandy or gravelly material. The members of the Santa Fe Formation are not discernable on this geophysical log. No borehole geophysical soundings were taken in the course of this project.

Table 2.2 Nomenclature Chart of the Santa Fe Formation in the Albuquerque, NM Area



From: Kelley, 1977

Nomenclature used in this report.

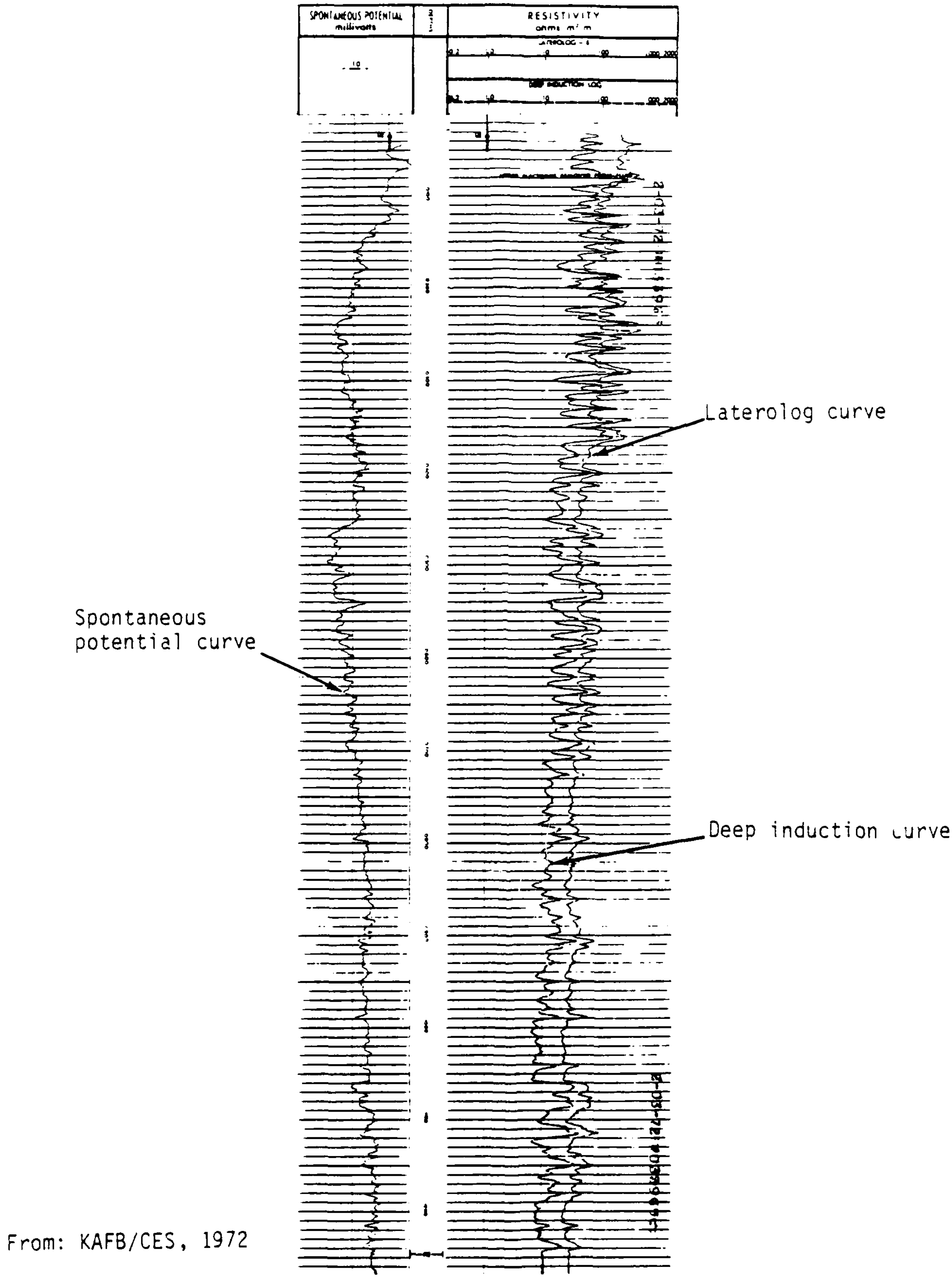
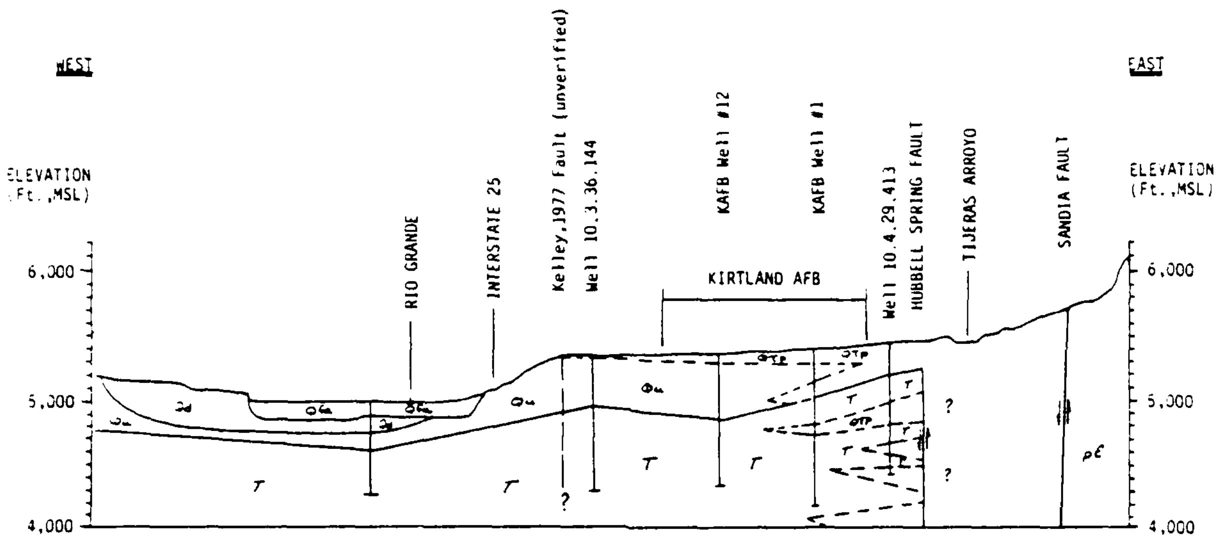


Figure 2.2 Geophysical Log for KAFB Well #11



Modified from: Lambert, 1968

LEGEND

Qfa - Quaternary-aged Floodplain Alluvium
Qd - Quaternary-aged Los Duranes Mbr.
Qu - Quaternary (to Tertiary)-aged Upper Buff Mbr. of Santa Fe Fm.
QTp - Tertiary to Quaternary-aged Pediment Gravels
T - Older tertiary sediments - undivided
pЄ - Precambrian crystaline rocks

SCALE

5 0 5 10 Miles

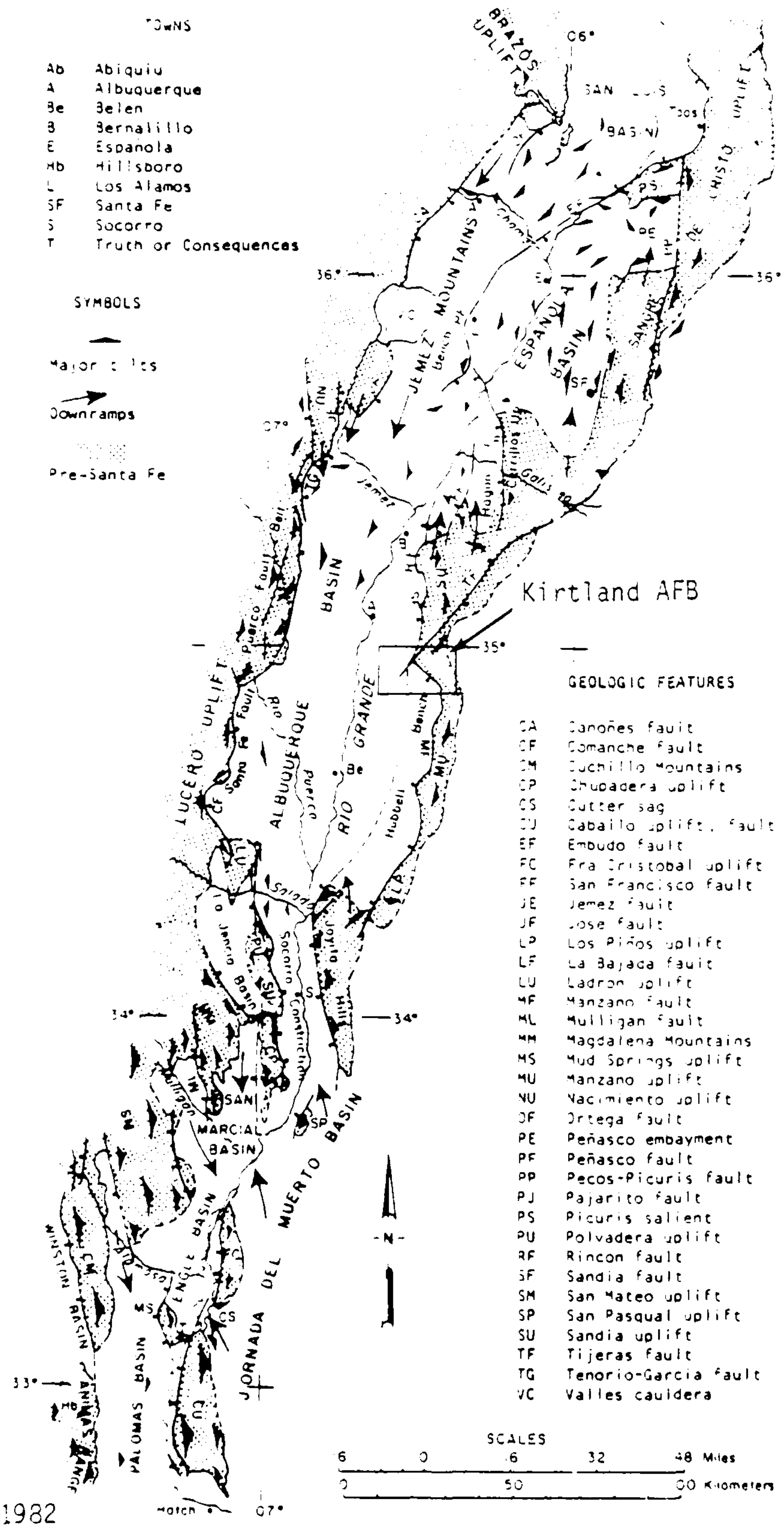
Figure 2.3 Regional Geologic Cross Section-Northern Kirtland AFB

2.3.2 Structure

The Rio Grande rift is composed of several en-echelon, north-northeast trending grabens which extend from southern Colorado into northern Mexico. The Albuquerque-Belen graben is a large, north-northeast trending, basin forming structural depression about 90 miles long and 30 miles wide. It is bounded to the west by the Rio Puerco fault zone and the Rio Puerco highlands, to the east by the Sandia and Manzano uplifts and to the north and south by complex fault constrictions (Woodward, 1982). Figures 2.1, 2.3-2.6, 2.9 and 2.10 show regional structural relationships in generalized plan and cross-sectional views. KAFB straddles the eastern edge of the Albuquerque-Belen graben of the Rio Grande Rift.

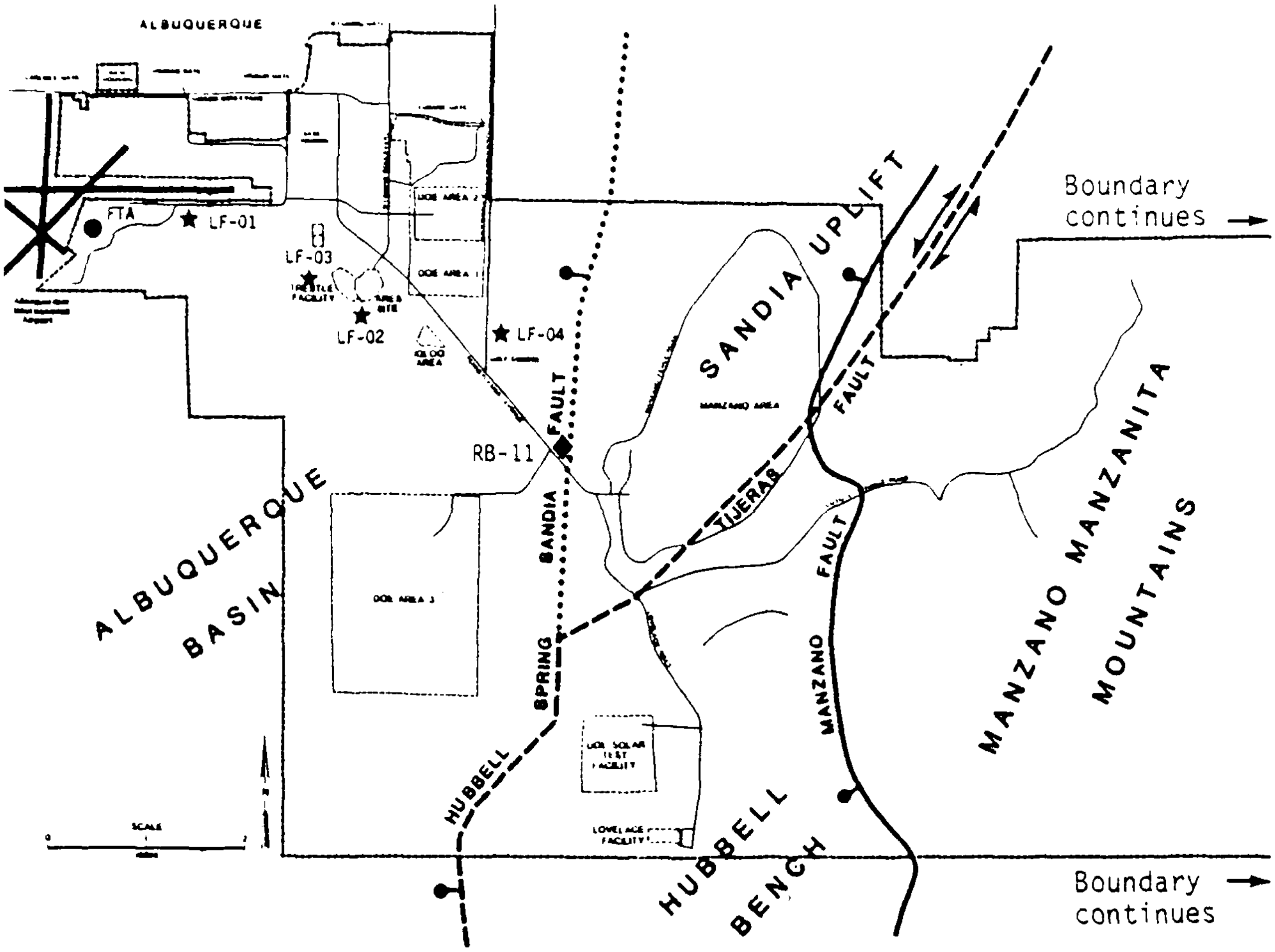
Grant (1981) identified four major fault zones on Kirtland AFB lands. Of these faults, the Sandia, Manzano, and Hubble Springs faults are north-trending, high angle, normal faults with displacements limits on the order of several thousands of feet (Woodward, 1982). By contrast the Tijeras Fault zone is a major northeast-trending fault that has a complex history of movement (Lisenbee and others, 1979) and appears to offset the Sandia and Hubbell Spring Faults. A search of the available geologic publications indicated that a description of the exact nature of this complex intersection of major structural features is not available.

The Sandia fault is the most critical structural element of this intersection with respect to the IRP study areas, namely the RB-11 site. While the other elements of the intersection have surface expressions of faults, the existence and general characteristics of the Sandia fault on Kirtland AFB was inferred from geological and geophysical date. Kelley, (1977) noted the structural relief of the Sandia fault is on the order of 1,500 to 2,000 feet. In the vicinity of RB-11, a controlled source audio-magnetotelluric (CSAMT) electromagnetic geophysical prospecting technique was applied in 1980-81 in order to determine a location of a part of the Sandia Fault. This study indicated a change in the apparent depth to crystalline bedrock from 700 - 800 meters to more than 1300 meters at the NW 1/4 Sec. 10, T.9N. R.3E. (Grant, 1981). The results of this survey are summarized in Figure 2.6. Gravity profiling surveys conducted by Parker (reported by Grant, 1981), failed to yield definitive faulting responses for surveys conducted north of the Manzano Area.



From: Kelley, 1982

Figure 2.4 Regional Structural Geology Map



Modified from: ESI, 1981

LEGEND

Geologic fault - bar and ball on downthrown side, arrows denote relative lateral movement. Dashed where inferred, dotted where concealed.

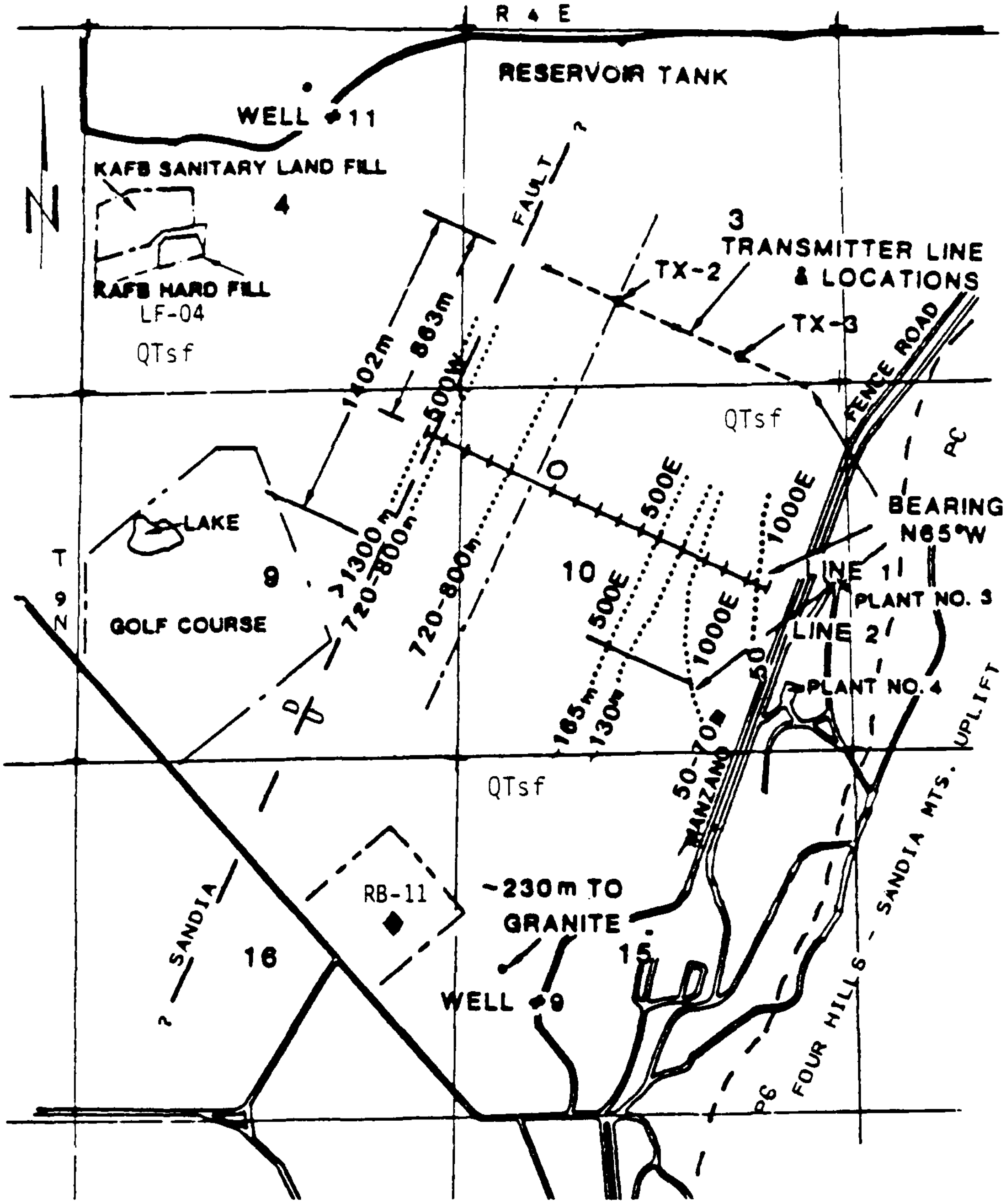
SANDIA UPLIFT Major geologic structure element

★ Landfill

◆ RB-11

● FTA

Figure 2.5 Kirtland AFB Geologic Fault Lines



Adapted from: Bartel, et al., 1980, in Riddle and Grant, 1981.

LEGEND

D	Sandia fault (D=downthrown side)
......	Depth to basement (granite) in meters.
QTsf	Santa Fe Formation
pC	Precambrian granite

Figure 2.6 CSAMT Geophysical Experiment (RB-11 Vicinity)

In cooperation with the 1606th ABW, SAI obtained several low-altitude, oblique angle aerial photographs of the southern portion of the Sandia fault area in an attempt to identify individual structural elements. The change in slope associated with the uplift of the Manzano and Manzanita Mountains has generated an apron of coalescing alluvial fan material that has obscured topographic and hydrologic fault trace indicators. The additional efforts required to define the location of the Sandia Fault are beyond the scope of this project.

2.4 REGIONAL HYDROLOGY

The hydrology of the Kirtland AFB area will be discussed in two general parts: (1) surficial hydrology, and, (2) subsurface hydrology.

2.4.1 Surficial Hydrology

The surficial hydrology of KAFB is composed of two major elements - natural and man-made drainages. The locations of these drainages are shown on Figure 2.7.

Man-made drainages are most significant in the northern portion of KAFB where there are large developed areas. LF-01 and the FTA areas recieve discharges from this drainage system in which flow occurrs only in response to local precipitation events. In early 1984, KAFB/SGPBE initiated a monitoring program to characterize the storm drainage flow for areas of KAFB north of Tijeras Arroyo. It is not apparent in Figure 2.7 but drainage from the TRESTLE and ARES facilities flows directly onto the LF-02 area. This uncontrolled drainage appears to have increased the potential for the infiltration of runoff through the LF-02 cover. These drainage problems for the FTA, LF-01, and LF-02 are discussed further in later sections.

The natural drainages are Tijeras Arroyo, Arroyo del Coyote, and an unnamed drainage located between Tijeras Arroyo and Arroyo del Coyote. Study areas LF-01, LF-02, LF-03, LF-04 and the FTA lie in or are immediately adjacent to Tijeras Arroyo. The RB-11 study area lies about 1,000 feet northeast of the Arroyo del Coyote drainage. The unnamed drainage diverts the bulk of surficial run-off events away from LF-04, which reduces the potential impact of local precipitation events.

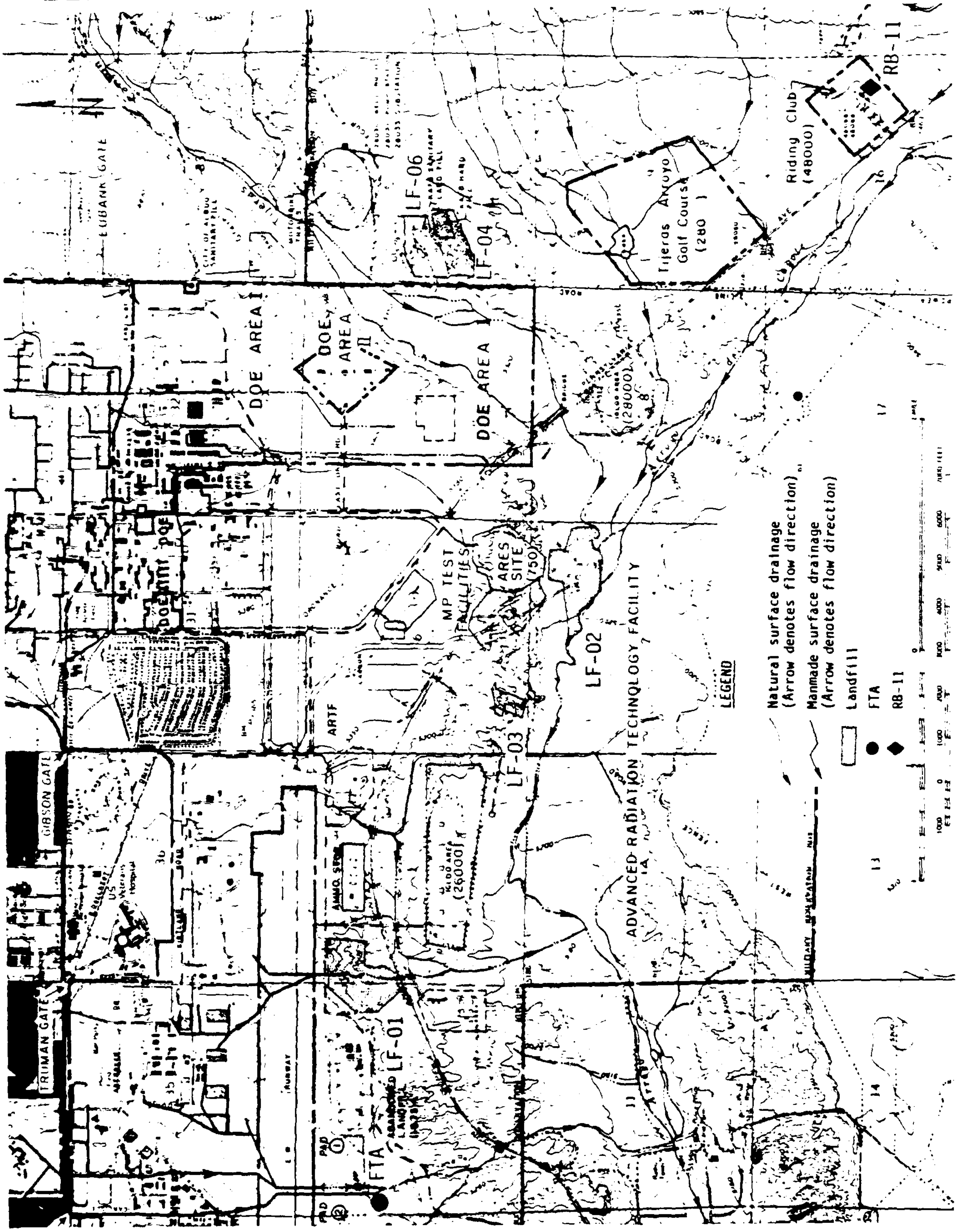


Figure 2.7 Surface Drainage Map

The Federal Emergency Management Agency (FEMA) (1983), in "Flood Insurance Study - City of Albuquerque, New Mexico", included parts of Tijeras Arroyo in their analyses. In the study above, a computer was used to generate a model of the discharge characteristics of Tijeras Arroyo with respect to rainfall events of varying magnitude. The results of the FEMA study are summarized below:

Tijeras Arroyo

Measurement Location	Drainage Area Square Miles	Peak Discharge in CFS 10yr	50yr	100yr	500yr
Upstream of Confluence with South Diversion Channel	114	4340	9150	14700	29400
At USGS gage, approx. 3 miles upstream of KAFB	75.3	5120	10000	14300	28600

The above estimates of discharge were generated by using the following assupmtions: US Soil Conservation Service approximation of rainfall characteristics, a variable storage coefficient flood routing method, and a one-hour, intense rainstorm-type distribution (FEMA, 1983).

FEMA (1983) analyses of floodway data indicate that, for a 100-year event, Tijeras Arroyo will have the following characteristics at the east and west boundaries of Kirtland AFB:

Location	Width	Area(Sq Ft)	Velocity Mean (ft/sec)	Elevevation* (Ft,MSL)
East Boundary of Kirtland AFB	224	983	13.1	5391.4
West Boundary of Kirtland AFB	224	1190	13.8	5165.7

*Elevation of the floodwater surface.

The recurrence periods of 10-, 50-, 100- and 500- years represent the average interval between floods of a given magnitude, with a 10, 2, 1 and 0.2 percent

chance, respectively, of being equalled or exceeded in a given year. The chances of a large flood event increase when periods of more than one year are considered. On 24 July 1967, a flood event with a discharge of 6,500 CFS occured in Tijeras Arroyo. This corresponds to an event with an average recurrence interval of 20 years (FEMA, 1983).

No flood flow data or calculations were available for Arroyo del Coyote or the unnamed drainage.

A flooding potential survey conducted by the U.S. Army Corps of Engineers (1979) determined the locations of 100- and 500-year flood boundaries in Tijeras Arroyo and Arroyo del Coyote. These maps indicate that only the LF-02 site is subject to flooding. The projected depth of flooding during a 100-year event is about 2 feet, with 70-80% of LF-02 being covered (Figure 2.8).

2.4.2 Subsurface Hydrology

Kirtland AFB contains three potential sources of ground water - fractured bedrock, shallow alluvial deposits, and the *unconsolidated and* semi-consolidated sedimentary deposits of the Santa Fe Formation. Wells east of Kirtland AFB typically rely on penetrating fractured or naturally permeable rocks for water. The shallow alluvial deposits are used as a source of potable water along the Rio Grande River floodplain. The Santa Fe Formation is the principle aquifer for the City of Albuquerque and Kirtland AFB. All of the IRP study sites lie over the Santa Fe aquifer.

Figure 2.9 depicts the regional configuration of water table elevations in the Albuquerque-Belen Basin area in 1978. Figure 2.10 shows a schematic cross section of ground water movement relative to geologic features at the south end of KAFB. A localized reversal of the regional ground water gradients has developed under Albuquerque and the northern part of Kirtland AFB in response to pumping activities. The exact location of the southern limit of this gradient reversal cannot be defined from the exisitng data.

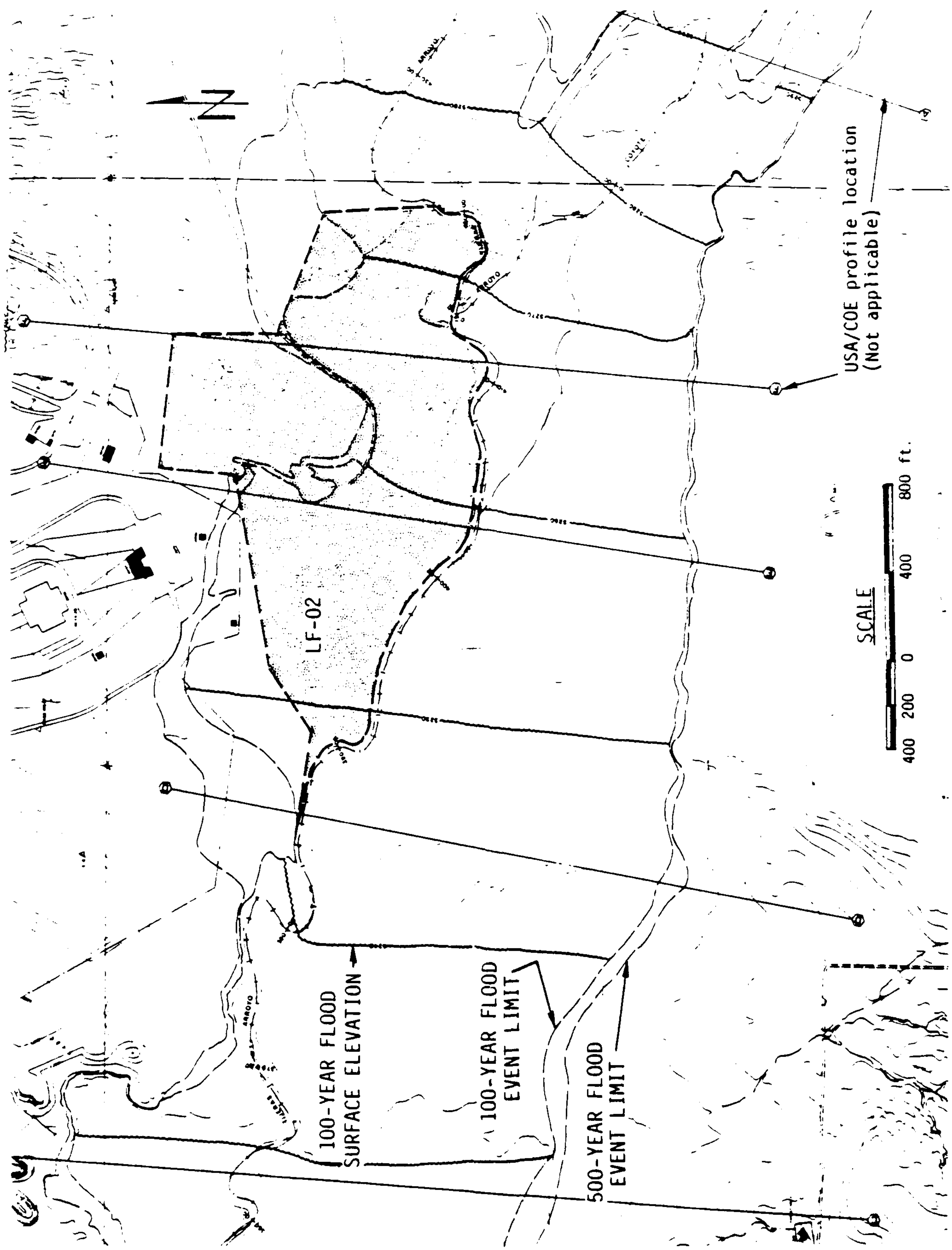
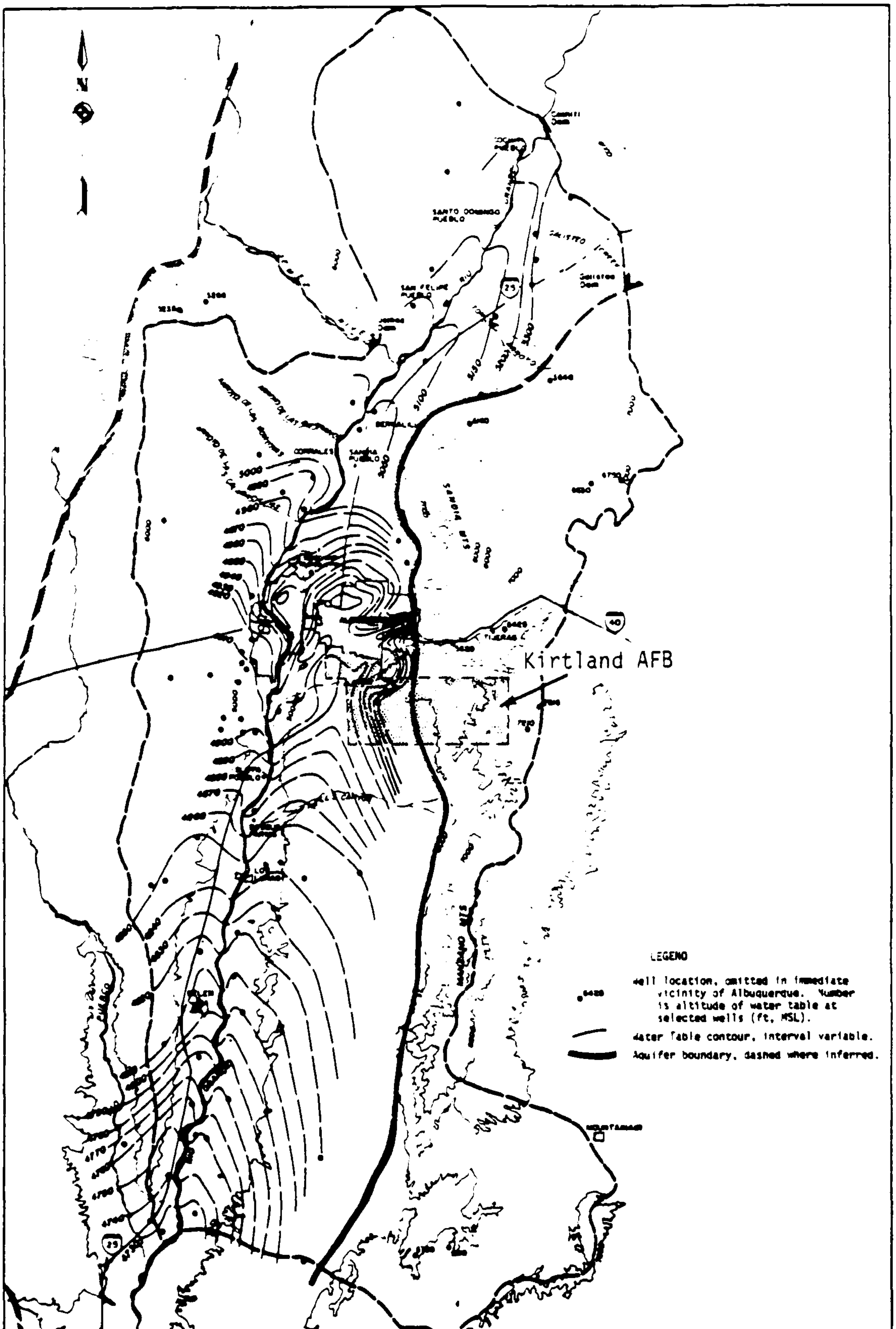


Figure 2.8 Landfill 02 Flooded Area Map



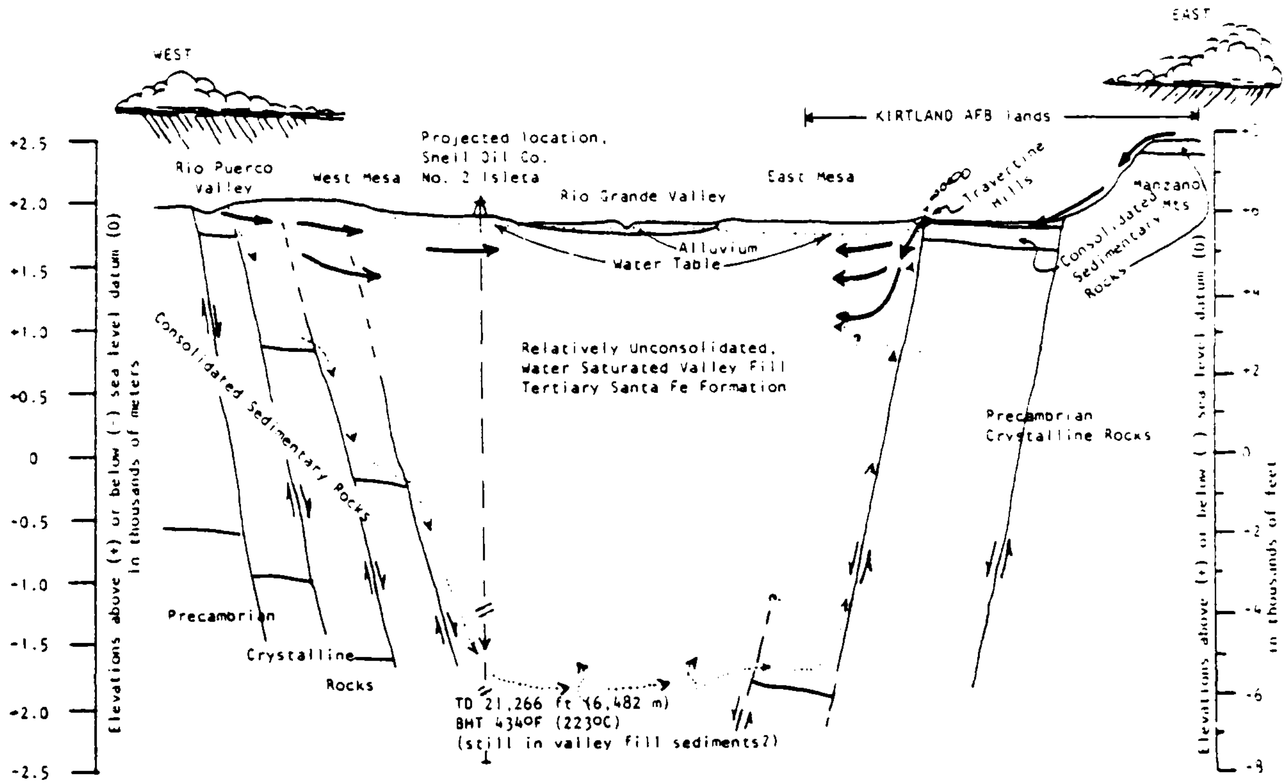
From: USA/COE, 1979

Figure 2.9 Albuquerque Basin Water Table Map, 1978

The Santa Fe Formation in the Albuquerque-Belen Basin is the most important source of ground water in the Albuquerque area. The water table aquifer has a regional gradient to the southwest of five to ten feet per mile. In the vicinity of Albuquerque, city well fields, KAFB Wells, and private wells have caused a cone of depression resulting in a localized change in the gradient direction. Figures 2.11 and 2.12 show the locations of KAFB- and City-owned ground water withdrawal areas. Kelly (1982) and COE (1979) have noted that the expansion of KAFB and City of Albuquerque water supply systems corresponds to the growth of the cone of depression. Figure 2.13, from KAFB records for production well #4, verifies the falling water table conditions reported by previous investigators. The rate of water table recession from 1977 to 1983 is approximately 2.7 ft per year. In response to the declining water table, KAFB has found it necessary to reset pumps at lower elevations in eleven of its wells. The City of Albuquerque is reported to have had similar problems and has shut down several older pumping stations.

Plate II shows water table elevations under Kirtland AFB lands at the end of July 1983. This map was prepared to determine the potential locations of two deep monitor wells to be constructed during this project. The map was constructed with time-consistent water level data from Kirtland AFB production records (Richardson, 1983-personal communication) and provisional data from the US Geological Survey (Kues, 1983 - personal communication). These water level data are presented in Appendix D. It is acknowledged that the USGS water level data are conditional and subject to revision. Production records from the City of Albuquerque wells were not available for this project due to ongoing Geological Survey water resource investigations. No date has been established for the release of these reports. The verification of the reported water level data was beyond the scope of this project. Measurements taken at DM-01 and DM-02 and the Veteran's Administration Hospital well in February 1984 yielded water level elevations of 4898 ft., 4903 ft., and 4891 ft., MSL respectively. These measurements correspond to depths of 421, 378 and 449 feet below ground surface, respectively. These readings confirm the current assessments of the water table conditions.

Plate II shows that all study sites are located over the southern edge of a cone of depression that has developed under the Albuquerque area. The water



From: Grant, 1981

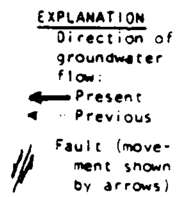
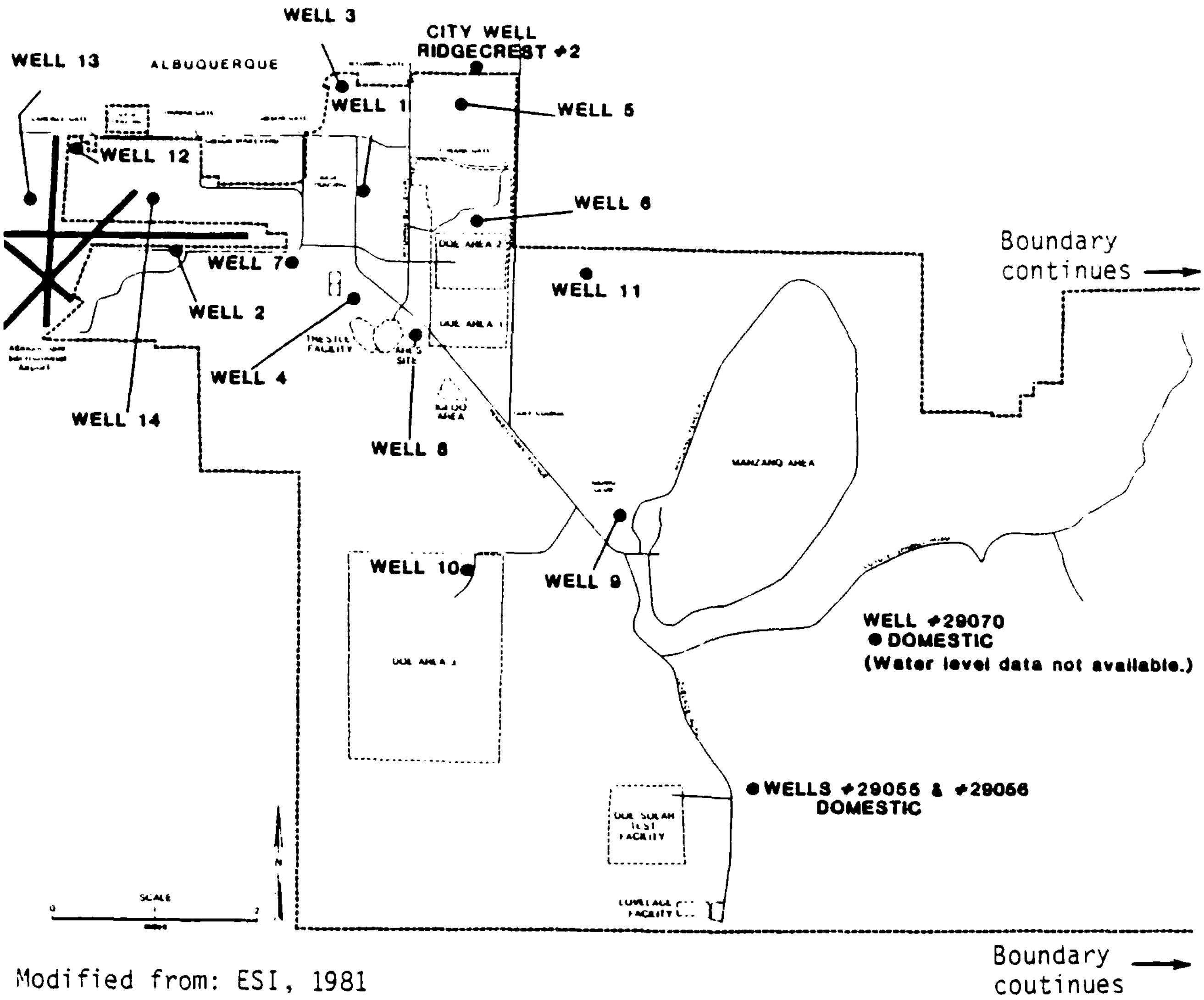
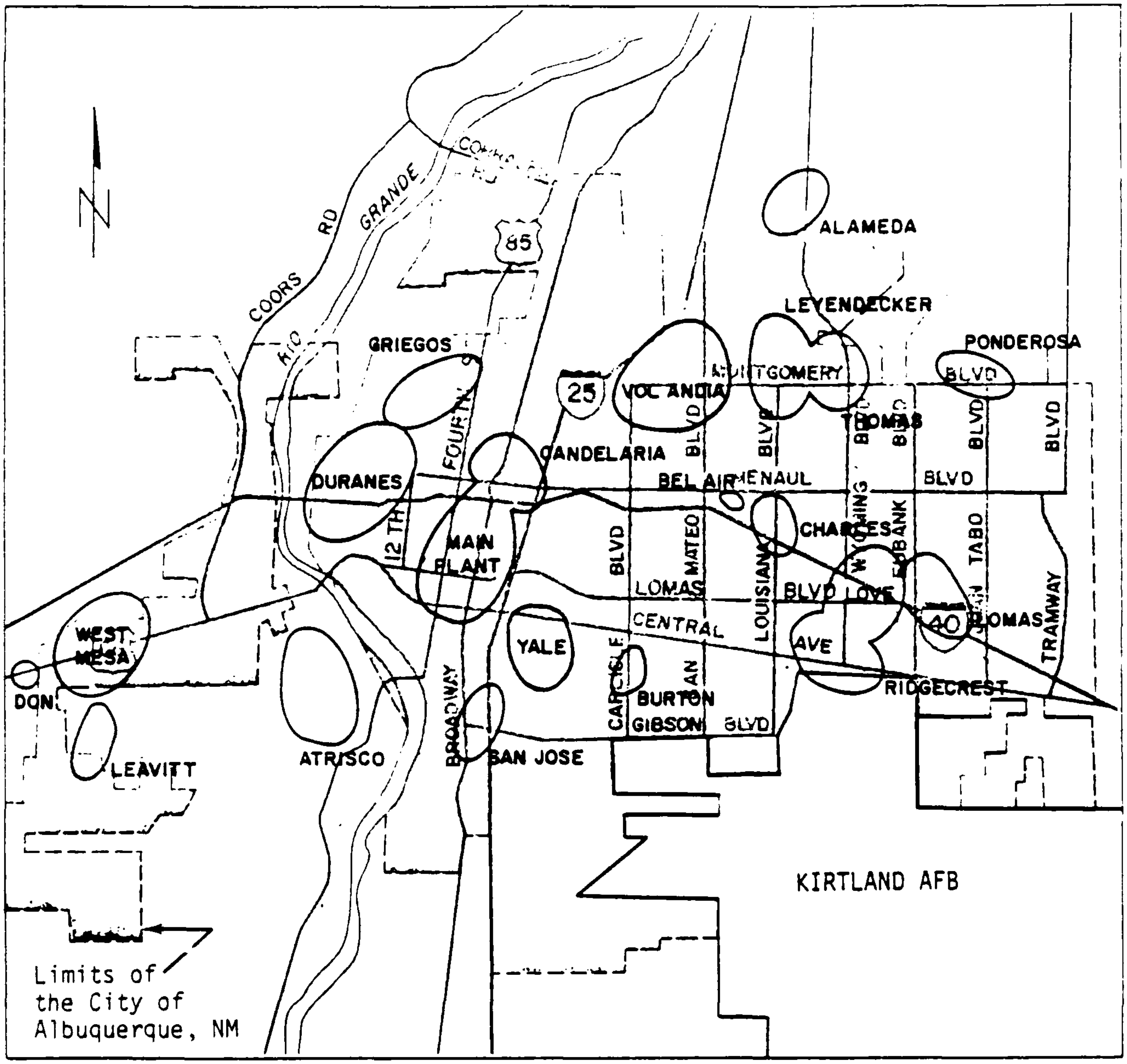


Figure 2.10 Schematic East-West Cross Section of the Albuquerque Basin



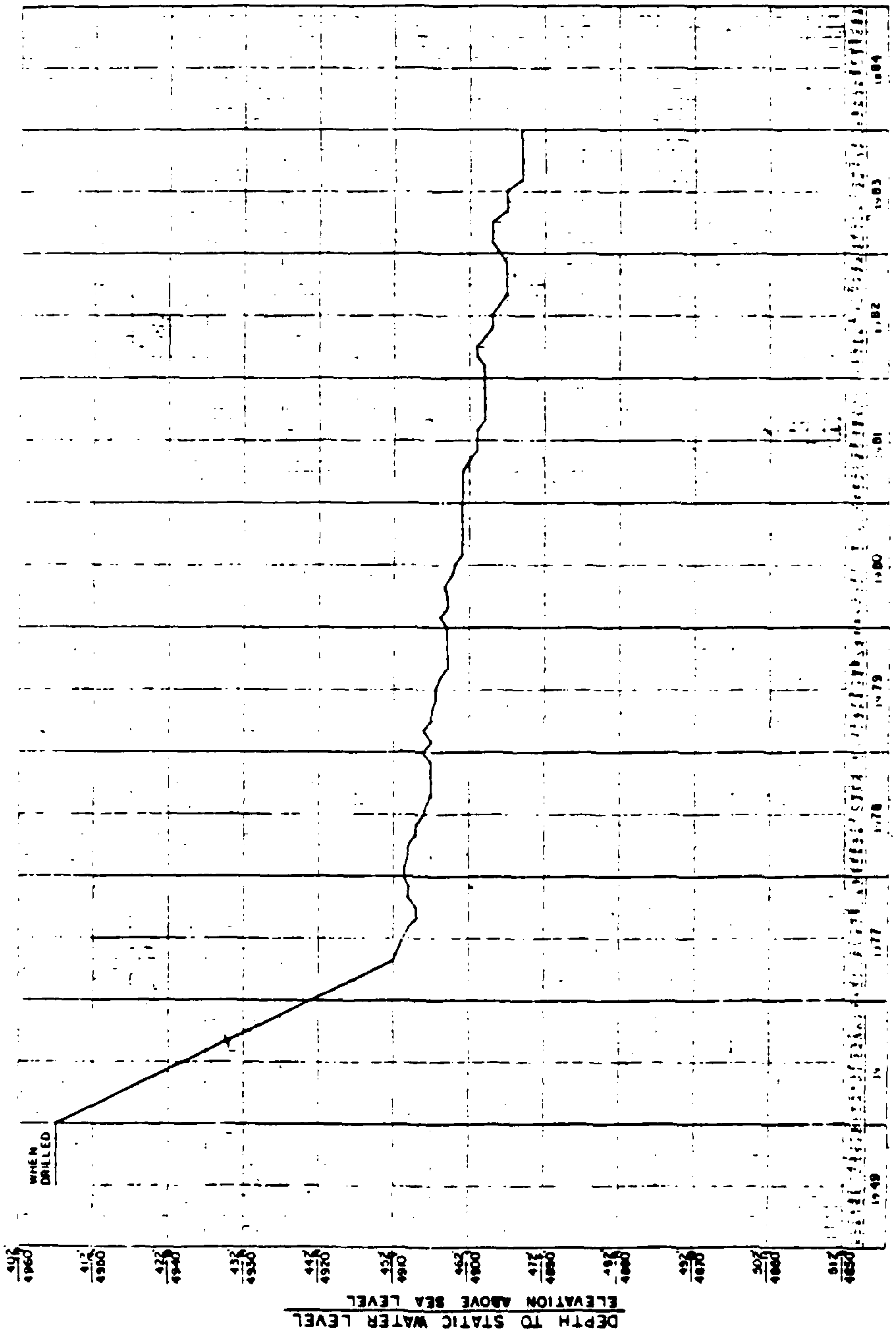
Modified from: ESI, 1981

Figure 2.11 Kirtland AFB Well Locations



From: COE, 1979

Figure 2.12 City of Albuquerque Well Field Map



From: KAFB/CES 1983

Figure 2.13 Static Water Level Plot for KAFB Well #4

table slopes to the north at a rate of five to ten feet per mile under the north part of KAFB and slopes northwest at a rate of 20 to 30 feet per mile near the RB-11 and LF-04 sites. The ground water ridge in the northwest portion of the mapped area is either the result of a change in data acquisition techniques or a real phenomenon associated with a fault of similar location and trend reported by Kelley (1978). Data generated during any follow-up work implemented at this base should be carefully studied to confirm the presence of this ridge and determine whether it has a significant impact on the analysis of potential contaminant dispersion paths.

The configuration of the water table outside of the contoured area could not be determined due to the lack of time-consistent data. Estimates of water level elevations and locations for the McCormick Ranch well, the building 29055 well, and Hubbell Springs are shown on Plate II for comparison. The determination of the characteristics of subsurface flow possibly associated with Tijeras Arroyo were beyond the scope of this project.

The available transmissivity data for the City of Albuquerque well field and selected KAFB production wells are presented in Table 2.3. The transmissibility is the rate at which an aquifer will yield water to a well and is normalized to a flow rate (gallons per day).

In the Albuquerque area the coefficient of storage (the volume of water an aquifer releases, or takes in, from storage per unit area of aquifer per unit change in head) is assumed to be 0.20 (Bjorklund and Maxwell, 1961). This value was based on lithologic characteristics rather than measured values (COE, 1978).

Calculations of ground water travel times between the IRP study sites and nearby water supply wells cannot be performed with any degree of accuracy at this time because the other data necessary for making a travel time estimate, i.e., hydraulic conductivity, porosity and hydraulic gradient, cannot be determined because of the stratification and heterogeneity of the Santa Fe Formation. The acquisition of the field data required to make these calculations was not within the scope of Phase IIB.

Table 2.3 Selected Transmissivity Values, KAFB and Vicinity

FIELD NAME	TRANSMISSIVITY (gal/day/ft) MINIMUM	MAXIMUM	AVERAGE	
City of Albuquerque (1)				
Atrisco	60,000	-	60,000	(2)
Burton	60,000	68,000	64,000	(3)
Charles	107,000	210,000	184,000	
Don	75,000	-	75,000	(2)
Duranes	6,500	62,000	32,900	
Griegos	21,000	55,000	31,400	
Leavitt	19,100	27,000	23,000	(3)
Leyendecker	150,000	600,000	450,000	
Lomas	3,000	60,000	31,500	(3)
Love	5,000	150,000	58,000	
Ponderosa	5,000	40,000	22,500	(3)
Ridgecrest	35,000	114,000	87,000	
San Jose	34,000	50,000	40,000	
Santa Barbara	112,000	-	112,000	(2)
Thomas	100,000	400,000	245,000	
Tracy	78,000	-	78,000	(2)
Vol Andia	102,000	300,000	173,400	
Volcano	49,000	-	49,000	(2)
West Mesa	27,000	50,000	37,200	
Yale	28,000	70,000	52,000	
Kirtland AFB				
# 4	-	-	678,365	(4)
# 8	-	-	344,488	(4)
# 10	-	-	7,500	(1)
# 11	-	-	23,586	(4)

(1) = COE (1979)
(2) = only one test
(3) = only 2 tests
(4) = SAI (1981)-one test

The principal water recharge sources of the Santa Fe Formation aquifer are:

- underground drainage from Hagen Basin to the north
- infiltration from the Rio Grande channel
- infiltration of precipiation and snowmelt into the coarser-grained materials on the margins of the basin.

Of these recharge areas, the coarse grained marginal materials are the most significant to the IRP investigations because the RB-11 and LF-04 sites lie atop or at the westward margins of this recharge zone. The RB-11 and LF-04 sites contained no significant ponding areas that would enhance the potential infiltration of precipitation run-off.

The recharge potential and possible baseflow conditions of Tijeras Arroyo could not be quantified with Phase II field data and available literature. Titus (1980) indicates that the aquifer-recharging effects of Tijeras Arroyo are restricted to an area within 1 to 1.5 miles of the mouth of Tijeras Canyon.

The vadose zone is described as the interval below the ground surface and above the water table and, on KAFB, varies in thickness from 54 feet at the Building 29056 well, to 588 feet at KAFB Well 6. The materials comprising the vadose zone are the unconsolidated beds of the Santa Fe Formation (See Section 2.3). Little is known about the character of the mid-and lower-portions of the vadose zone. The characterization of these portions of the vadose zone by field testing was beyond the scope of Phase IIB.

The vadose (unsaturated zone) represents the greatest barrier to vertical contaminant transport at all the IRP study sites. The effectiveness of this barrier is a function of the thickness, grain size, sorting and mineralogy of the individual beds that constitute the Santa Fe Formation. These parameters vary widely within the Santa Fe Formation and will be unique to each study site.

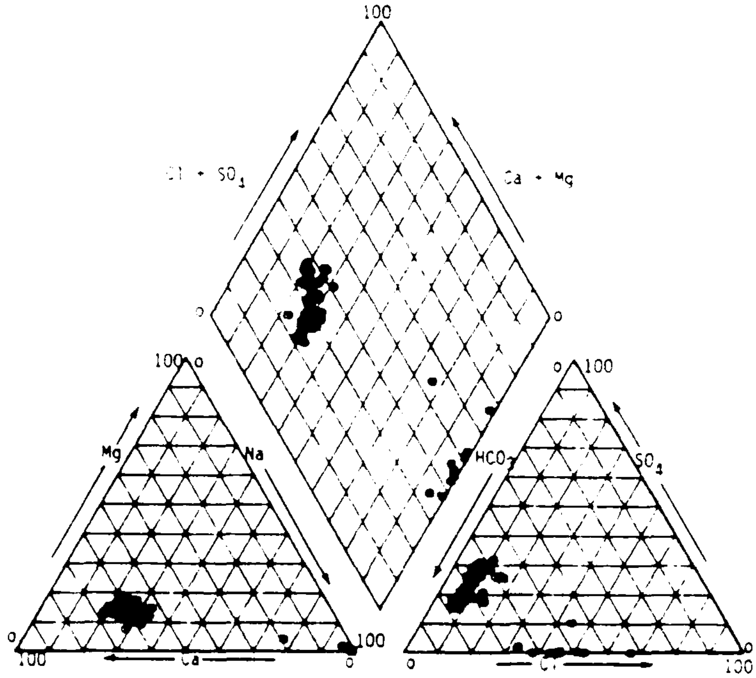
2.5 REGIONAL GEOCHEMISTRY AND HISTORIC WATER QUALITY ISSUES

The geochemical processes which determine the chemical quality of the Albuquerque-Belen Basin ground water have been described by Bjorklund and Maxwell (1961), Theis (1938), Clayton (1966), Heggen (1979), Hines (1981), Hudson (1982), USACE (1979), McQuillan (1982), Thompson and McQuillan (1984), Titus (1980) and others. Generally, these authors have contributed works resulting from investigations into specific areas of concern within and adjacent to the Albuquerque-Belen Basin.

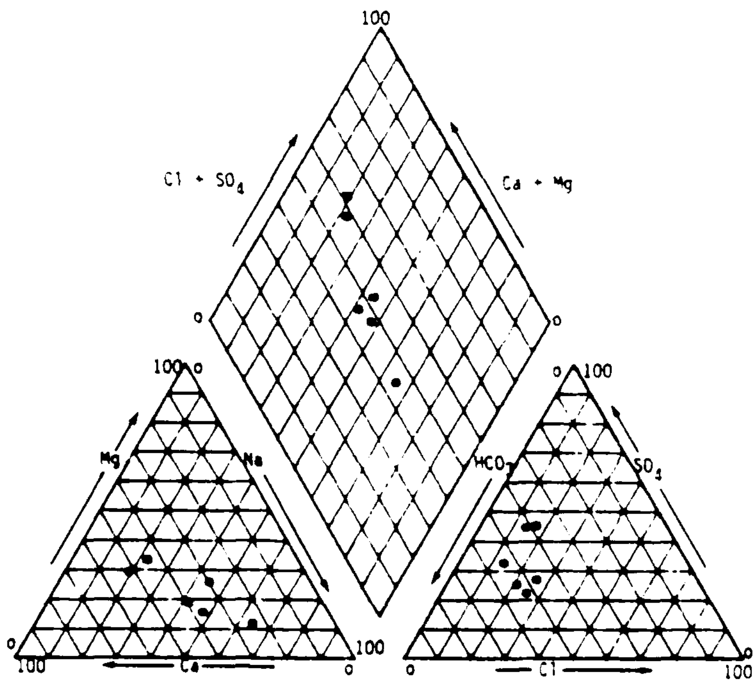
Waters from each of the major recharge areas described in the previous section have distinct composition resulting from the water/rock interactions which characterize each source area. The major ion compositions of waters from the various Albuquerque municipal well fields are shown on Piper plots in Appendix D. The available KAFB geochemical data are compared with City of Albuquerque-San Jose well field data in Figure 2.14. Location of selected Albuquerque municipal wells and all KAFB production wells are shown in Plate II.

With some exceptions, the waters depicted on the Piper plots (Figure 2.14 and Appendix D) are predominantly calcium bicarbonate. Major increases in sodium are noted for the San Jose well field which lies west of KAFB and for City of Albuquerque wells west of the Rio Grande. The West Mesa and Leavitt well fields show an increase in sodium which may be attributed to the apparent shallow depth of thermal waters (and concomitant increases in dissolved alkali minerals) associated with the Recent volcanic deposits. Temperatures for waters produced in these fields have been reported to be in excess of 90 degrees F (USACOE, 1979). The sodium increases noted for the San Jose, Atrisco, and Duranes fields may be attributed to the flushing of alkali deposits from water-logged soils which occurred after construction of irrigation return flow drains in the 1930's (USACOE, 1979). The reversal in the ground water gradient toward the major city production fields may be responsible for drawing the higher sodium waters from the irrigated valley areas toward the San Jose production field.

From 1967 to 1968, a significant increase in the sodium and chloride levels occurred for KAFB production wells 1E, 3E, 4E, 5E, 6E, and 7E



KAFB PRODUCTION WELLS



SAN JOSE WELL FIELD

Figure 2.14 Piper Plots for the San Jose Well Field and KAFB Production Wells

(KAFB/CES, 1983). This abrupt increase in sodium and chloride concentrations is not understood at this time. However, the transient nature of the observed sodium chloride and increases suggests that the increase is not due to a general shift in the water quality of these KAFB production wells.

Other water quality data for KAFB are sporadic. Complete data for KAFB production wells are not available for the period from 1979 to the present. In 1981 KAFB gathered single water samples from production wells 1, 3, 11, 12, 13 and 14. The results of this sampling effort are presented in Appendix D. 1, 1, 2, 2, tetrachloroethylene was detected in trace amounts (between 0.6 and 0.3 mg/l) in wells 1, 3 and 12.

2.6 OFF-SITE WATER USERS AND POTENTIAL CONTAMINANT SOURCES

Within the Albuquerque ground water basin, the following areas are considered to be significant with respect to ground water use/contamination:

- Mountainview and Pajarito subdivisions of Albuquerque's South Valley.
- The San Jose well field which lies west of KAFB on the eastern escarpments of the Rio *Grande* "inner valley".
- The Tijeras Canyon area east of the City of Albuquerque and Kirtland AFB.
- The Eubank Landfill which lies directly east of KAFB in the north bank of Tijeras Arroyo.

The location of these areas are shown on Plate I. Contamination of the shallow ground water in Albuquerque's South Valley is receiving increasing public attention and has been the subject of state and federal investigations. Thompson and McQuillan (1984) have provided a comprehensive review of the literature and data related to the nitrate contamination of the Mountainview and Pajarito areas.

Nitrate contamination in the Mountainview area has been widely held to be the result of the high density of local private waste-water treatment systems, animal feedlot activity, and municpal waste treatment operations in the area. However, geochemical evidence presented by Thompson and McQuillan (1984) shows that the conditions present in the Mountainview area would preclude the

wastewater system as an exclusive contamination source. Citing the lack of a reducing environment (anaerobic soil conditions resulting from high water table and high organic waste loading) and, observed nitrate contamination which seems to be moving as a plume in a southwestward direction, Thompson and McQuillan (1984) suggest that the high nitrate levels may be due to "historical nitrogenous discharge which is now dispersing and moving hydraulically down gradient and not the result of continuous on-going infiltration from wastewater systems". Additionally, the denitrification of organically bound nitrogen from wastewater systems discharge does not in itself serve to produce the high nitrate levels (in excess of 500 mg/l) which have been observed in the Mountainview area.

McQuillan, et al, (1982) have provided an inventory of the potential organic and industrial waste generators in the San Jose area with information and data related to the ground water depth, analytical data on several monitoring wells for various organic contaminants, and other relevant data. Although the operational history of plants operating in the area with regard to ownership is complex, the major industrial contributors of hydrocarbon, volatile organics, acids, ethers, ketones, aliphatic hydrocarbons, and poly-cyclic compounds have been identified. The presence of organic contaminants in two of the City of Albuquerque (San Jose) wells caused these wells to be shut down in 1979 and 1980. This area is still being investigated by the NMEID, the Federal EPA, and other private investigators.

Although the South Valley ground water contamination cases seem to involve two generally distinct areas of concern (i.e. nitrate contamination in the Mountainview and Pajarito areas and organic/hydrocarbon pollution in the San Jose area), the area is generally regarded as being quite vulnerable to ground water contamination due to the following:

- Extremely shallow ground water depths.
- High density of private domestic wells and wastewater treatment systems.
- Combined agricultural and industrial use of ground water.
- Industrial and municipal disposal activities.

The proximity of Tijeras Arroyo to the South Valley contamination area has led several local citizens groups and state officials to consider KAFB as a potential contributor to the contamination. Despite the lack of evidence of contamination in soil samples collected from boreholes adjacent to the KAFB landfills near Tijeras Arroyo, there still remains the potential for the surface transport of contaminants in Tijeras Arroyo to the Mountainview area. Additionally, the operational histories of LF-02 and LF-01 predate or coincide with the time period in which the localized ground water gradient reversal has occurred. The data collected in this study does not confirm or deny whether the Tijeras Arroyo has provided a flow path for contaminants to the South Valley area.

The potential for contaminant introduction to the surface and ground water systems east of KAFB has not been thoroughly addressed. Titus (1980) has provided an inventory of potentially contaminated wells in the Tijeras Canyon area due to high nitrate levels. Again, domestic wastewater system overloading in a high population density area near Carnue has been suggested as the source of the high nitrate levels observed in this area of Tijeras Arroyo. A connection between the nitrate contamination observed in the South Valley and Tijeras Canyon areas has not been discussed or investigated, but preliminary analyses indicate that the two problem areas are not related to a common source.

2.7 SITE DESCRIPTIONS

The environmental features of each site have been described in Section 1.2.

3.0 FIELD PROGRAM

The following sections address the Phase IIB field program development and implementation, instrumentation used and sampling procedures.

3.1 FIELD PROGRAM DEVELOPMENT

The Phase I report by Engineering Science provided recommendations for the investigation of seven landfill sites. Included were recommendations to drill and install soil moisture lysimeters at LF-01, LF-02, LF-03, LF-04, LF-06 and RB-11. Soil sampling was recommended for the FTA. The recommended priority for the investigation of these sites was presented in Section 1 of this report.

In August, 1982, SAI provided OEHL with the Phase II-A report, "Presurvey Report-Hazardous Material Disposal Sites KAFB". The purpose of this report was to provide OEHL with cost, schedule and task descriptions for carrying out the objectives of the Phase I recommendations. SAI indentified four major task areas to be accomplished in the IIB portion of the IRP. The four task areas were:

Task-1 Pre-installation activities

- Define lateral and vertical extent of each landfill by geophysical and aerial photo techniques.
- 100-foot exploratory borehole at each site to characterize general subsurface conditions.
- Provide recommendations for lysimeter construction and placement.

Task-2 Drilling, monitoring equipment installation and testing

- Drilling and soil sampling and analyses at the FTA.
- 24 slanted borings with soil sampling and lysimeter installation and testing at six landfill sites.
- Survey of the borehole locations and landfill boundaries.

Task-3: Initial contaminant identification monitoring

- Sample recovery from lysimeters.
- Analyses of 24 lysimeter-water samples or 24 representative soil samples or a combination thereof.

- Recommendations for long term monitoring.

Task-4: Long-term monitoring and reporting

- Develop schedule for long-term monitoring of 24 lysimeter assemblies.
- Final report preparation with recommendations for remedial action.

During preparation of the Phase IIA report, SAI selected the firm of Fox and Associates to provide geotechnical services and to assist with geophysical surveying, exploration borehole drilling and lysimeter installations. The firm of Scanlon and Associates was retained to provide surveying services. All geochemical analyses were scheduled to be performed by the JRB Associates Division of Environmental Chemistry and Geochemistry, La Jolla, CA. The procedures used by SAI to secure the subcontracts mentioned above were detailed in the Phase IIA report.

The Phase IIA report also delineated those areas where quality assurance and chain-of-custody documentation were required. With the exception of geophysical surveys and 100-foot exploratory borehole drilling, all field efforts were preceded by procedure manuals (Appendix F) wherein the required tasks, sampling documentation and sample handling requirements were delineated. SAI representatives were on site for all phases of the field investigations except for various geophysical transects and parts of monitor well development.

During the implementation of the tasks defined in the Phase IIA report, SAI was contacted by OEHL and requested to modify the proposed plan of investigation. SAI complied with those requests and generated a revised approach. The results of this modification are outlined below. The deviations from the Phase IIA report are underlined.

Task 1 Pre-installation investigation

- Define the lateral and vertical extent of each landfill by seismic refraction, geophysical surveying, and aerial photo analyses.
- An initial 100-foot deep exploratory borehole at each site to characterize gerneral subsurface conditions.
- Provide recommendations for lysimeter construction and placement.

- Verify existing water table conditions for optimum location of two ground water monitoring wells.

Task 2 Drilling and monitoring equipment installation and testing

- Drilling and soil sampling and analyses at the FTA.
- Seven slanted borings with soil sampling, lysimeter installation and testing at five landfills.
- Install two ground water monitoring wells "down gradient" from the landfills.

Task 3 Initial contaminant identification monitoring

- Sample ground water monitoring wells.
- Sample recovery from seven slanted lysimeters.
- Analyses of seven lysimeter-water samples or seven representative soil samples and one sample from each monitoring well.
- Recommendations for long-term monitoring of lysimeters and monitoring wells.

Task 4 Long-term monitoring and reporting

- Develop schedules for long-term monitoring of seven lysimeters and two ground water monitoring wells.
- Final report preparation with recommendations for remedial actions.

3.2 FIELD PROGRAM IMPLEMENTATION

The field program was implemented in discrete parcels indicated below.

3.2.1 AERIAL PHOTO REVIEW

The photographs reviewed for the Phase IIB effort were selected from the archives of SAI, the KAFB Civil Engineering Section and the KAFB Base Historian. The SAI archives consisted of color and black and white, oblique aerial photographs at various scales taken during Phase IIA in 1982 and partial stereoscopic coverage at a scale of about 1"=40,000' taken in 1980. KAFB Civil Engineering provided black and white stereoscopic photos at a scale of about 1"=600'. This coverage was flown in 1971 and covered LF-01, LF-04, RB-11 and FTA areas. The photographs provided by the KAFB Base Historian were black and white oblique aerial photos at various scales covering the RB-11 and TRESTLE sites and were probably taken in 1974.

Available aerial photos were reviewed with the intent of determining the general limits and the methods of operation for the landfills. The photos were examined for vegetation linearity, surface disturbances, and other features which could be inferred to represent landfill activity. The results of this review have been incorporated in the Section 5 discussions of this report.

In addition to these archival reviews, SAI and Fox and Associates conducted interviews with KAFB personnel who were familiar with the operational history of several of the landfill areas and were able to identify specific areas of landfill operations. This was especially helpful in the cases of LF-02 and RB-11 where precise boundaries were difficult to discern using only field observations.

3.2.2 GEOPHYSICAL SURVEY

The seismic refraction surveys conducted at the subject sites were performed with a 12-channel Geometric Nimbus seismograph using either one-half or one-pound kinepac explosive charges. The investigation was performed along "lines" crossing the study sites. The "lines" at the sites were aligned to determine (or verify) landfill boundaries and fill depths. Generally, the data (cross sections) depicted suspected and reported conditions. Due to interpolation between points (geophones and shot points) and heterogeneous subsoil conditions, the quality of data obtained from seismic refraction surveys varies. Because of the uncertainties inherent in the refraction survey technique, a limit of confidence of #10 to 20 percent is estimated for all depths and distances (Fox, 1984). These geophysical data are shown in Appendix I and have been incorporated into the site cross sections presented in Section 1.

3.2.3 LANDFILL BOUNDARY DETERMINATION

The landfill boundaries were defined by aerial photograph analysis, personel interviews and field reconnaissance and seismic refraction geophysical surveys. The interpretation of these data was consistently conservative. The data were examined for indications of burial activity with no single data type dominating the boundary location decisions. Where data were inconclusive, the boundary was set to exclude undisturbed areas.

The results of these efforts are presented in Section 2.7 with field survey data in Appendix H. Boundary closure was obtained for the LF-01, LF-03 and RB-11 sites. Field staking of landfill boundaries at LF-02 and LF-04 were keyed to prominent local features such as Tijeras Arroyo in the case of LF-01 and the fenceline around the active landfill (LF-06) in the case of LF-04.

3.2.4 BOREHOLE LOCATION DETERMINATION

Borings were made to gather four basic types of data; 1) site characterization to depths of 100 feet, 2) ground water level and quality, 3) lysimeter-related data and 4) shallow geochemical sampling (at the FTA). The criteria used to optimize borehole locations are described below. A key factor in choosing borehole locations was a stipulation that the boreholes were not to penetrate fill materials.

Site characterizations to depths of 100 feet were required as these data did not exist prior to Phase II. The verification of subsurface conditions was required to assess the validity of installing the recommended lysimeter assemblies. The locations of these boreholes are given on Figures 1.3 through 1.19. In all cases locations were picked that would characterize the largest possible area within the subject landfill.

The LF-01 exploratory borehole was located to provide data regarding a suspected alluvium-Santa Fe Formation contact and to assess potential moisture build-up associated with surface water flow restrictions caused by the railroad spur.

The LF-02 borehole was located to investigate the vertical extent and nature of the Tijeras Arroyo flood plain deposits and to investigate increased soil moisture conditions potentially associated with a linear phreatophyte trace observed 100 feet west of the borehole.

The LF-03 exploratory borehole was located to investigate a suspected alluvium-Santa Fe Formation contact. Pre-landfill topographic maps indicated that fill material had probably been placed over this contact.

The LF-04 exploratory borehole was located to investigate a suspected alluvium-Santa Fe Formation contact and increased soil moisture conditions potentially associated with surface water flow path disruption caused by Powerline Road.

The RB-11 exploratory hole was located at the southeast corner of the burial site. There were no topographic features or geologic formation contacts that requied investigation. The Sandia Fault could not be located in the field and could not be described with only one borehole.

The ground water monitoring wells were located down gradient from the two largest study areas, LF-01 and LF-02. A water table map, based on the available July 1983 data, was constructed to verify reported gradient directions (Plate II, in pocket).

All lysimeter boreholes were drilled at angles of 45° to 50° below horizontal with the objectives of placing the porous section of the lysimeters under the edge of the landfills and subsequently withdrawing native soil moisture samples for analyses. In general, moisture/grain size relationships (determined by the exploratory boreholes) and access to landfill edges dominated the location criteria.

At LF-01, lysimeter LF-01-01 was located at the southern toe of a well defined fill-containing area. Lysimeter LF-01-02 was located on the east bank of the surface drainage channel as this site offered the greatest potential for encountering and sampling elevated soil moisture adjacent to the bottom of the landfill.

At LF-02, lysimeter LF-02-01 was located at the eastern edge of the landfill in an area where the transmission line from the sanitary sewer lagoons to the KAFB golf course is reported to have leaked. Lysimeter LF-02-02 was located in the central portion of the landfill where field reconnaissance identified a haulage road passing through the landfill. The road was used to gain safe access to the bottom of the landfill.

At LF-03, the lysimeter LF-03-01 location was at the southern toe of the landfill. This location allowed the maximum possible reach under the landfill as well as the potential to sample an area that had the highest probability of encountering soil moisture for sampling. Lysimeter LF-03-02 was installed to replace lysimeter LF-03-01 which was damaged beyond repair during installation. The location criteria used for LF-03-01 were applied to the second installation.

At LF-04 the lysimeter location criteria were identical to those applied to LF-03. This lysimeter required several attempts to reach the target area.

At RB-11 the lysimeter was so located as to reach under the largest observed trench scar with consideration for the reported trench depth.

The shallow soil sampling performed at the FTA used nine boreholes arrayed in a three-by-three grid in the cement pad area with a tenth borehole about 250 feet to the north for background samples. This drilling plant deviates from that initially proposed in that the control boring is 250 feet away-not 300 yards and boring FTA-10 was drilled through the cement pad to a depth of 20 feet. The control boring was moved closer to the FTA due to access restrictions and maintain lithologic continuity in the rapidly changing Santa Fe Formation. FTA-10 was drilled through the pad because a 3x3 grid pattern was requested and the adopted pattern was the most efficient use of project funds. A depth of 20 feet was opted for based on field observations of the cuttings. Boring FTA-10 was backfilled with natural materials, with a dry powered bentonite mix in the uppermost three feet and an asphaltic patch cap. All borings except FTA-10 were drilled to depths of ten feet. FTA-10 was drilled to a depth of 20 feet in an attempt to assess the vertical extent of contamination under the cement pad.

3.2.5 EXPLORATORY DRILLING

Prior to determination of the depths for placement of the lysimeters and in order to provide more information on the lithology and soils at each of the landfill locations, single 100-foot, vertical exploration boreholes were drilled at all study sites except the FTA. The data which were to be generated by these borings included moisture content, density, grain size

distribution, and lithology. Section 3.2.4 of this report describes the location of the exploration boreholes at each study site. Section 4.4 describes the methodology employed for collecting soil samples from these borings. Appendix E contains logs of the borings and related data.

3.2.6 FTA DRILLING AND SAMPLING

On 3 November 1983, Fox and Associates and a geologist from SAI drilled eight boreholes in the immediate vicinity of the FTA pad to a depth of ten feet. Soil samples were collected at 1, 5 and 10 feet with a split spoon sampler. Soil samples were immediately sealed in half pint Mason jars and refrigerated. These samples were shipped to the JRB laboratory in La Jolla, Calif. for analyses. Geologic logs of these borings are given in Appendix I. A map of the borehole locations is shown on Figure 1.19. Each soil sample was analyzed for oil, and grease. Results of these analyses are presented in Appendix G. Borehole FTA-01 was drilled 300 feet north of the FTA pad to define background conditions. Borehole FTA-10 was drilled to a depth of 20 feet to investigate the lower reaches of potential contaminant migration underneath the cement pad.

3.2.7 GROUND WATER MONITORING WELLS

The proposed IRP investigation methodology was altered to include two ground-water monitoring wells to be located hydraulically down-gradient from the landfill areas. Rodgers and Company, an Albuquerque-based, licensed water well drilling firm, was contracted by Fox and Associates to construct the wells. Cuttings logs and completion data were documented by an on-site SAI geolgist. These data are located in Appendix E. All DM-01 and DM-02 activities were carried out per the procedures given in Appendix F.

On 22 December 1983, drilling activites were intitiated at the DM-01 site. DM-01 was drilled to a depth of 480 feet with a Gardner-Denver 1000 drill rig using a 8.75-inch retipped soft-formation tricone drilling bit from 0 to 480 feet. The drilling fluid used was Baroid "Quik Gel"$_{TM}$ bentonite drilling mud mixed with KAFB production well water. This drilling fluid was mixed on an as-needed basis from 0 to 480 feet. DM-01 was cased to a depth of 475 feet with 5.5-inch OD, threaded, schedule 40 PVC. The interval from 415

to 465 feet, was screened with 0.020-inch slot, threaded, schedule 40 PVC screen. No solvents or glues were used in the construction of DM-01. The backfill schedule consisted of #10-20 washed silica sand placed at depths from 409-475 feet, a bentonite seal was placed at depths from 406-409 feet, and natural materials at depths from 0 to 406 feet. Placement depths for the backfill materials were verified with a 500-foot long 0.50-inch tremmie pipe. The well was completed with an 8-inch locking steel cap set in a concrete pad. Prior to installation of the casing and backfill materials, the drilling mud in the mud pits and borehole was removed and replaced with clear, KAFB production well water. Drilling activities at DM-01 were completed on 30 December 1983.

On 3 January 1984 drilling activities were initiated at the DM-02 site. DM-02 was drilled to a depth of 450 feet with a Gardner-Denver 1000 drill rig using the same 8.75-inch retipped soft-formation tricone bit used at DM-01. The drilling fluid used was Baroid "Quick Gel"TM bentonite drilling mud mixed with KAFB production well water. This drilling fluid was mixed on an as-needed basis from 0 to 450 feet. DM-02 was cased to a depth of 438 feet with 5.5-inch OD, threaded schedule 40 PVC. The interval from 378 to 428 feet was screened with 0.020-inch slot, threaded PVC screen. No solvents or glues were used in the construction of DM-02. The backfill schedule consisted of #10-20 washed silica sand placed from a depth of 370 to 450 feet, a bentonite pellet seal placed from a depth 367 to 370 feet, and natural materials from 0 to 367 feet. Placement depths for the backfill materials were verified with the aformetioned tremmie pipe. The well was completed with an 8-inch diameter locking steel cap set in a concrete pad. Prior to installation of the casing and backfill materials, the drilling mud in the borehole and mud pits were flushed out and replaced with clear KAFB production well water. Drilling activites at DM-02 were completed on 10 January 1984.

3.2.8 LYSIMETER INSTALLATIONS

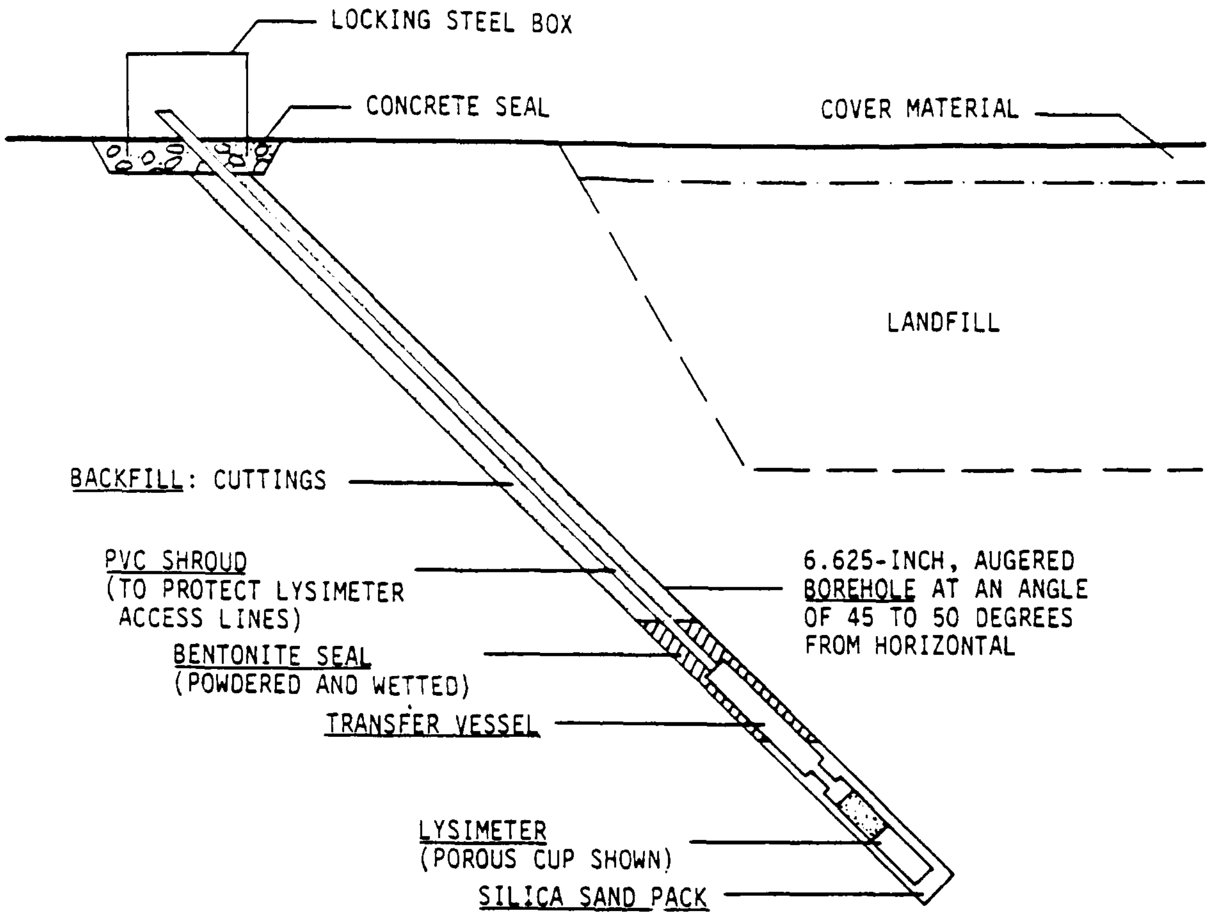
ESI, in their Phase I report, recommended that lysimeters be installed at the periphery of each landfill in order to monitor the soil moisture-contained contaminants in the unsaturated (vadose) zone directly beneath the sites. This recommendation was based on the high priority ranking given to the subject landfills and more importantly, because of the relatively large

vertical depth to ground water in the area. It was felt the likelihood of detecting possible contaminant migration from the landfill sites would be considerably greater by monitoring the vadose zone directly beneath the sites than by sampling the ground water at depth. Figure 3.1 shows a schematic diagram of lysimeter installations used at KAFB. A detailed sketch of the KAFB lysimeters is given on page I-23.

In general, a lysimeter is a device used to withdraw liquid samples from unsaturated, permeable media. The withdrawal of liquids is typically accomplished by the application of vacuum pressures to the lysimeter. Once in the lysimeter assembly, the liquid is lifted to the surface (through dedicated tubing) by positive pressure application. In the past, lysimeters have been typically used by soil scientists and agronomists to investigate shallow (less than 10 feet) soil moisture conditions. Installation depths over 30 feet are considered very deep. The needs of the KAFB IRP (50-60 foot setting depths at 45-50^{o} angles) necessitated the use of a modified version of the standard lysimeter.

The lysimeter assemblies installed at KAFB are characterized as modified, deep-sampling, Teflon$_{TM}$ lysimeters. These assemblies consist of three major components-a porous cup section (to which the vacuum pressure is applied and where liquids enter the samples), a non-porous section, isolated from but in the same unit as the porous cup (for preliminary sample lift) and a transfer vessel (entirely nonporous- used to contain liquids from the preliminary sample lift as well as the positive pressure required to ultimately lift the sample to the surface). A ball-check valve, modified to function at an angle of 45^{o} to 50^{o} isolates the porous cup from the non-porous sections. Liquid samples are lifted to the surface via semi-rigid Teflon$_{TM}$ tubing enclosed in ar PVC shroud. All materials contacting the liquid sample are made of Teflon to ensure uncontaminated samples. No solvents or glues were used in the lysimeter assemblies.

During the evaluation of the applicability of lysimeters to the KAFB monitoring needs it was determined that the application of a vacuum (negative) pressure to a liquid sample would result in degassing of the sample. This degassing would affect organic compounds of high volatility. In order to



Modified from: Fox, 1984

NOT TO SCALE

Figure 3.1 Schematic Diagram of a Lysimeter Installation

compensate for this degassing, SAI considered a sampling option that included dedicated volatile organic compound absorbent tubes (Tenex) on all evacuation lines. This sampling option was not implemented. The existing lysimeter assemblies are easily modified for this sampling option.

The lysimeter assemblies were installed as follows:

1. Drill angled hole to target depth with hollow-stem auger. Ultimate placement point determined by the materials encountered.

2. Drill an additional 2 to 2.5 feet to accommodate that part of the lysimeter assembly below the porous cup.

3. Attach the sample lines and shroud to pre-assembled, pre-washed lysimeter. The shroud is assembled with rivets only (no glues or solvents).

4. Lower complete lysimeter assembly into position.

5. Place sand pack around porous cup. The placement was accomplished with a 3/8-inch ID tremmie pipe and sand blaster. The sand pack was placed dry and placement depths were verified with the tremmie pipe.

6. Apply approximately two gallons of distilled water to settle sand pack and establish capillary connection with native soil moisture.

7. Install approximately one foot of powdered bentonite and activate seal with one gallon of distilled water.

8. Verify functional status of installed assembly (by application of positive pressure to all lines and monitoring of pressure decay).

9. Backfill borehole to surface with natural materials.

10. Install locking steel cover and set in cement.

The details of sample acquisition from the lysimeter assemblies are presented in Appendix F.

On 1 February 1984, drilling was initiated at LF-03 and proceeded through sites RB-11, LF-04, LF-02 and LF-01. The lysimeters were installed by 13 February 1984. Appendix I contains the materials logs and completion data for the seven lysimeters.

During the drilling of the seven lysimeter boreholes, some of the following problems were encountered:

- The hollow stem auger tended to drift from the initial angle of 45 to 50 degrees from horizontal to a flatter trajectory when encountering gravels and cobbles. This necessitated the abandonment of several borings, when the auger drifted above the target depths.

- Retrieval of the split spoon soil sampler was difficult due to the curvature of the hollow stem auger described above.

- Recovery of the auger after lysimeter emplacement was also complicated due to the curved nature of the borehole. This problem caused the breakage of the first lysimeter installed at LF-03 which was replaced and tested on 8 and 9 June 1984.

Section 3.4 describes the methods that were used to log and collect soil samples from the lysimeter borings. These soil samples were collected and archived (sealed, labeled in triplicate and frozen) so that they could be selectively analyzed if the lysimeters did not produce sufficient liquid sample.

On 3 April 1984 SAI initiated the lysimeter performance monitoring as described in Appendix E. At the outset of the lysimeter testing, it became apparent that the lysimeters would not sustain a vacuum by means of a hand pump which was supplied by the manufacturer. Instead, SAI utilized a portable battery powered vacuum pump, which was capable of sustaining approximately 14" to 16" of mercury of vacuum pressure. Repeated applications of these vacuum ranges for periods up to eighteen hours did not yield soil moisture samples.

On 11 April 1984 SAI elected to cease further lysimeter monitoring and chose to analyze the previously archived soil samples which were collected during the lysimeter borehole drilling. The soil samples collected at depths closest to the depth of lysimeter emplacement were submitted to JRB's subcontracted laboratory - Environmental Research Group in Ann Arbor, Michigan. Results of these analyses are given in Table 4.3 and Appendix G.

3.2.9 FIELD SURVEY OF LANDFILL BOUNDARIES AND BOREHOLE LOCATIONS

In order for KAFB to plan for future activities with regard to the landfills investigated under this study, a permanent record of the location of

the fill boundaries was needed. In order to accomplish this task, SAI, in cooperation with Scanlon and Associates, surveyed and mapped the location of the landfill lateral extents and borehole locations. The plan view surveys of the five landfills and the FTA are included in Appendix H. Boundary closures are not indicated for Landfills 2 and 4 because field staking efforts were keyed to major landmarks, namely the Tijeras Arroyo active channel (in the case of LF-02) and on a fence line defining the active landfill (in the case of LF-04). All landfill boundaries were marked with flush set, No. 4 rebar (a steel rod approx. 0.7 in. diameter by 2 feet long) and red plastic caps and have been located with reference to permanent KAFB benchmarks and grid system. At the FTA, boreholes FTA-02 through FTA-09 were marked with florescent orange stakes, FTA-10 was marked with a stainless steel "gin gear", and FTA-01 with a rebar and cap. The location of the landfill boundaries were established based on geophysical survey results, aerial photo review, on-site reconnaissance, air reconnaissance, and discussion with base personnel. The locations were field staked by SAI and Fox and Associates prior to surveying by Scanlon and Associates.

3.3 FIELD INSTRUMENTATION AND EQUIPMENT

The field instrumentation and equipment used during Phase IIB consisted of the following items:

(1) The seismic refraction survey was performed with a 12 channel Geometric Numbus seismograph using either a one-half- or one-pound kinepac explosive as an energy source except RB-11 where a 12-pound sledge hammer was used due to the shallow trench depths and short line lengths.

(2) All drilling equipment was washed at the KAFB steam-cleaning rack prior to collaring all borings. All drill rigs and equipment were steam-cleaned prior to exiting KAFB property. All washing events were observed and documented by SAI representatives.

(3) The vertical soil borings for the initial 100-foot boreholes and FTA investigations were drilled with a CME-55 truck-mounted drill rig using 6-inch, hollow stem, continuous flight power auger. The holes were advanced to the target depth and samples were taken at changes of material or at a maximum of 10-foot inervals. The samples were collected using a modified California Sampler driven by a 140-pound hammer.

(4) The ground water monitoring wells were installed with a Gardner-Denver 1000 drill rig using an 8-inch retipped soft formation drill bit and standard circulation of bentonite drilling mud.

(5) The ground water well monitoring required the use of a Powers, Co. Well Sounder$_{TM}$, a 500-foot, two wire electric tape for water level determination and a Chemtrix Type 700 conductivity bridge for water quality indications during water sample acquisition.

(6) The lysimeter assemblies were installed using a CME-55 truck-mounted drill rig, factory-modified to perform slanted borings. The lysimeter assemblies installed during Phase IIB were provided by Timco Mfg., Inc. and in general, consist of a standard, shallow-setting type teflon lysimeter plumbed to non-porous teflon transfer vessel (used to lift a sample from depths over 20 feet-see page F-50).

(7) Sample acquisition from the lysimeter assemblies was attempted by applying a vacuum of 10-17 inches of mercury with an electric vacuum pump driven by long-life, 6-volt batteries or a gasoline-powered generator. Waters collected by vacuum application were tested with a Chemtrix Model 700 conductivity bridge to determine if formation water was being generated.

(8) It was initially anticipated that KAFB would supply a down-hole, gamma-ray logging tool for the assessment of subsurface radiological conditions in the RB-11 area. This tool was non-operational during the Phase II field effort. In lieu of down-hole, gamma-ray logging, radiologic monitoring was performed on soil samples at the surface with sensitive, hand-held detectors. RB-11-E was monitored with a Ludlum, Model 10 Micro R Meter, calibrated 2 February 1983. RB-11-01 was monitored with a Technical Associates, Model TBM-3, calibrated 18 January 1984.

3.4 SAMPLING PROCEDURES

Three types of sampling efforts were attempted during Phase IIB and are discussed in the following subsections and procedure manuals for each sampling effort are presented in Appendix F.

4.4.1 SOIL SAMPLING

Soil sampling was conducted during three of the different drilling phases of this project, which were:

- The exploration drilling at each landfill location.
- The drilling at FTA.
- Drilling of the lysimeter borings.

Soil samples for the exploration holes were collected by a 2.5-inch, modified California Sampler with inserted brass liners. The sampler was advanced by driving a 140-pound hammer through a 6.5-inch hollow stem auger. Samples were collected at a change in lithology or every ten feet, whichever was less. Upon retrieval of the sampler, sample liners were collected for engineering analysis by Fox and Associates. Sample splits were made for storage and freezing at KAFB facilities in the event that geochemical analyses were requested in the future.

Samples from the FTA drilling were collected in a manner similar to that used on the exploration holes. Samples were collected at 1-, 5-, and 10-foot depths for borings FTA-01 through FTA-09. FTA-10 had samples collected at 5, 15, and 20 foot depths. All samples were placed immediately in half-pint Mason jars, sealed with 4-inch wide Teflon tape, closed with their respective brass lids, marked and stored on ice (then frozen at the end of the day).

Soil samples for the lysimeter borings were collected with a two-inch stainless steel, split-spoon sampler at five-foot intervals. Each sample was collected by opening the sampler and immediately placing the soil sample in a half pint Mason jar and immediately sealing the container with 4-inch Teflon tape between the sample and lid. All samples were labled in triplicate with chain of custody forms completed on each soil sample collected.

3.4.2 MONITOR WELL SAMPLING

Geologic logging was performed by the examination of drill cuttings brought to the surface with bentonite-water fluid and normal circulation drilling methods. No soil samples were retained as these drilling conditions preclude the acquisition of representative grain size and geochemical data.

The sampling methods used to gather water samples at DM-01 and DM-02 are described in detail in Appendix F. The results of these sampling efforts are summarized in Appendix G and Section 5.

Well DM-01 was sampled on 11 and 23 January 1984. The sample collected 11 January 1984, was destroyed during interim storage. Well DM-01 was resampled on 23 January 1984. Well DM-02 was sample on 27 January 1984.

All water sample analyses were performed by the Environmental Research Group, Inc., Ann Arbor, MI.

3.4.3 LYSIMETER SAMPLING

The sampling methods used to attempt soil moisture (liquid) sample acquisition from the seven lysimeters are described in detail in Appendix F. This sampling methodology failed to yield liquid samples from the lysimeters due to a combination of low soil moisture content and coarse sand pack size. In lieu of lysimeter-generated water samples, archived soil samples representative of the porous cup (intake) area were submitted for analyses (See Section 4.4.1 for soil sampling techniques).

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 DISCUSSION OF RESULTS

Results of analyses for soil and water samples collected during the Phase IIB efforts are presented according to the following schedule:

	Sampling Area	Results
o	Soil samples collected from the Fire Training Area	Table 4.1 and Appendix G
o	Water samples collected from two groundwater monitoring wells	Table 4.2 and Appendix G
o	Soil samples collected from lysimeter borings	Table 4.3 and Appendix G

Soil samples from the FTA were analysed for total organic halogens (TOX-see Section 1.3) and oil and grease in order to determine the presence and extent of jet fuel and other possible solvents used at the aircraft mockup area during past fire training exercises. The results of these analyses are presented in Table 4.1. These analytes are considered to be indicator parameters and no federal or state guidelines are available for comparison. Samples FTA-01-01, FTA-01-05 and FTA-01-10 were taken approximately 300 feet north of the mockup pad for purposes of background determination. With the exception of organic chloride in sample FTA-01-10 taken at a depth of 10 feet, all other parameters were reported as "none detected" (ND). The value of 3.6 mg/kg organic chloride for FTA-01-10 is within the upper range of values reported for other soil samples collected in proximity to the pad and mockup. The presence of jet fuel residues was confirmed in four samples collected adjacent to and beneath the pad and mockup by the presence of oil and grease in samples FTA-09-01, FTA-10-01, FTA-10-15 and FTA-10-20.

At ground water monitoring wells DM-01 and DM-02, water samples were gathered for analysis of total organic halogens (TOX), total organic carbon (TOC) and nitrate nitrogen. The results of these analyses and other pertinent data are presented in Table 4.2. Both ground water monitoring wells showed detectable levels of organic chloride and nitrate nitrogen. Well DM-02

Table 4.1 Summary of Fire Training Area Analyses

Sample No.[1]	TOX[2] (mg/Kg)	Oil and Grease[3] (mg/Kg)	Sample No.	TOX (mg/Kg)	Oil and Grease (mg/Kg)	Sample No.	TOX (mg/Kg)	Oil and Grease (mg/Kg)
FTA-01-01	Cl: ND[4] Br: ND I: ND	< 100	FTA-01-05	Cl: ND Br: ND I: ND	< 100	FTA-01-10	Cl: 3.6 Br: ND I: 0.06	< 100
FTA-02-01	Cl: 3.7 Br: ND I: ND	< 100	FTA-02-05	Cl: 3.7 Br: ND I: 0.08	< 100	FTA-02-10	Cl: 3.1 Br: ND I: ND	< 100
FTA-03-01	Cl: 3.6 Br: ND I: ND	< 100	FTA-03-05	Cl: ND Br: ND I: ND	ND	FTA-03-10	Cl: ND Br: ND I: ND	< 100
FTA-04-01	Cl: ND Br: ND I: ND	ND	FTA-04-05	Cl: ND Br: ND I: ND	ND	FTA-04-10	Cl: 0.5 Br: ND I: ND	ND
FTA-05-01	Cl: ND Br: ND I: ND	ND	FTA-05-05	Cl: 0.5 Br: ND I: ND	ND	FTA-05-10	Cl: 1.6 Br: ND I: ND	ND
FTA-06-01	Cl: ND Br: ND I: ND	ND	FTA-06-05	Cl: 0.8 Br: ND I: ND	ND	FTA-06-10	Cl: ND Br: ND I: ND	ND
FTA-07-01	Cl: 1.6 Br: ND I: ND	ND	FTA-07-05	Cl: 3.4 Br: ND I: ND	ND	FTA-07-10	Cl: 1.1 Br: ND I: ND	ND
FTA-08-01	Cl: 0.5 Br: ND I: ND	ND	FTA-08-05	Cl: 0.9 Br: ND I: 0.04	ND	FTA-08-10	Cl: 0.9 Br: ND I: ND	ND
FTA-09-01	Cl: ND Br: ND I: 0.08	3900	FTA-09-05	Cl: ND Br: ND I: ND	ND	FTA-09-10	Cl: ND Br: ND I: ND	ND
FTA-10-05	Cl: 4.9 Br: ND I: ND	1300	FTA-10-15	Cl: 3.3 Br: ND I: 0.1	6500	FTA-10-20	Cl: 3.8 Br: ND I: 0.1	1200

1) For FTA-01-05: FTA = Fire Control Training Area
   01 = Borehole No.
   05 = Depth of Sample (ft, BGS)
   All samples collected 3 November 1983.
2) TOX = Total Organic Halogen Scan - consisting of: organic Bromide (0.5), organic Chloride (0.04), organic Iodide (0.02). Detection limits in parentheses. mg/Kg = milligrams per kilogram
3) By infrared spectrophotometer.
4) ND = not detected; < 100 = detected but unquantafiable, concentration below indicated level.

TABLE 4.2 SUMMARY OF WATER SAMPLING AT WELLS DM-01 AND DM-02, KIRTLAND AIR FORCE BASE, NM

PARAMETER	DM-01	DM-02
Screened Interval	415-465 ft, BGS(1)	378-428 ft, BGS
Total Depth	475 ft, BGS	438 ft, BGS
Static Water Level	421 ft, BGS	378 ft, BGS
Pump Intake	440 ft, BGS	398 ft, BGS
Pumping Rate	8 hrs at 1 gpm	5 hrs at 2 gpm
Field Conductivity	290 mmhos	650 mmhos
Collection Date	23 January 1984	27 January 1984
Sample Number	DM-01 #2(2)	DM-02 #1
TOX (Haloscan)		
Organic Chloride	0.02 mg/l(3)	0.1 mg/l
Organic Bromide	ND(4)	0.004 mg/l
Organic Iodide	ND	ND
Total Organic Carbon	ND	ND
Nitrate Nitrogen	0.03 mg/l	4.0 mg/l

(1)ft, BGS = feet below ground surface
(2)DM-01 #1 destroyed in transit
(3)mg/l = milligrams per liter
(4)ND = not detected

Table 4.3 Summary of Lysimeter Analyses

1) Parameter / Landfill	LF01-01	[4])LF01-02-A	[4])LF01-02-B	LF02-01	LF02-02	LF03-01	LF04-02	RB11-01	Detection Limit
2) Depth	62 ft.	49 ft.	49 ft.	62 ft.	42 ft.	58 ft.	58 ft.	53 ft.	NA
Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	NA
Haloscan (TOX)									
Organic Chloride	ND[6]	ND	ND	ND	ND	ND	ND	ND	0.2 mg/Kg
Organic Bromide	ND	ND	ND	ND	ND	ND	ND	ND	0.05 mg/Kg
Organic Iodide	ND	ND	ND	ND	ND	ND	ND	ND	0.02 mg/Kg
Oil and Grease (by IR)	< 200	ND	ND	ND	ND	ND	ND	ND	200. mg/Kg
5) Lead, Total	8.	3.	< 3.	ND	ND	ND	5.	ND	3. mg/Kg
5) Sodium, Total	380.	180.	110.	60.	72.	68.	1200.	660.	
5) Iron, Total	22000.	26000.	22000.	44000.	86000.	9300.	28000.	18000.	
5) Mercury, Total	NA	NA	NA	NA	NA	NA	NA	< 0.1	0.1 mg/Kg
5) Silver, Total	NA	NA	NA	NA	NA	NA	NA	< 0.8	0.8 mg/Kg
2,4-D	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDT, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDE, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDD, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
3) Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	0.50 mg/Kg
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
Lindane	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	0.050 mg/Kg
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
2,4,5-T	ND	ND	ND	ND	ND	ND	ND	ND	0.0050 mg/Kg
Moisture	14%	12%	13%	2%	2%	3%	5%	5%	NA

1) All parameters reported in mg/Kg unless otherwise noted.
2) Drilled length, at 50° angle from horizontal, measured from surface.
3) Higher detection limit due to matrix interference (ERG Comment).
4) Duplicate analysis run on LF02-02-49.
5) Whole rock hydrofluoric digestion instead of water-soluble analytes.
6) ND = Not Detected, NA = Not Applicable to sample set. < = Positive result but unquantifiable. Concentration below indicated level.

(down-gradient from LF-02) also showed detectable organic bromide. The New Mexico Water Quality Control Commission relations specify a nitrate/nitrogen standard of 10.0 mg/l. Neither nitrogen nitrate analysis exceeds this standard. There are no specific standards for halogenated organic compounds as such.

Background levels for these parameters are not available as the two DM wells were completed in the upper fifty feet of the saturated zone of the ground water beneath KAFB (KAFB wells are completed in the upper 500 feet of the saturated zone) and there are no wells for which water quality data were available in an upgradient (SE) direction. However, upon examination of the chemical quality of samples collected from the KAFB production wells (see Appendix D), the two DM well samples do not show nitrate levels above those levels reported for these wells. There are no KAFB background data for the evaluation of TOC results and the single water samples showed TOC concentrations below the laboratory detection limit of 2.0 mg/l.

The validity of the DM monitor well data is qualified even though these two wells showed stabilized specific conductance and suspended solids production at the time of sampling. The wells were pumped and bailed a limited amount (1000 gallons) prior to sampling. Approximately 3500 gallons of fresh (KAFB production well) water was circulated through each well to remove cuttings and drilling mud prior to development, casing, bailing, and pumping. As a small but unknown volume of this water entered the formation during flushing. Thus, these data from the DM monitor wells should be considered only as preliminary data and should be verified by additional pumping and sampling.

Soil samples from the lysimeter intake area were collected during the drilling lysimeter borings and were analysed for total organic halogens, selected pesticides, oil and grease, and selected inorganics (see Section 1.3). Soil samples were submitted for analyses in lieu of soil moisture (water) samples from the vacuum lysimeters. Each sample submitted for analysis, selected from archived samples, was from as close to the zone of lysimeter placement depths as possible. With the exception of one sample (LF-01-02 which showed oil and grease at less than 200 mg/kg- detectable, but

at a concentration below quantifiable detection limit), all analyses for organic halogens, oil and grease, and selected pesticides were not detected. Inorganic analyses for lead, sodium and iron were based on whole sample digestion, and are thus not directly amenable to interpretation for contaminant identification. These samples were inadvertently analyzed by total sample digestion as opposed to the requested water extraction and there are no applicable state or federal standards for total sample digestion analyses. The results of the RB-11 sample (also by whole sample digestion) analysis for total mercury and total silver were below laboratory detection limits of 0.1 and 0.8 mg/Kg, respectively. This sample is indicative of a portion of only one of at least nine trenches at the RB-11 site.

LF-01 straddles a geologic contact separating the Santa Fe Formation and recent alluvium. The exact location of this contact is unknown, but can be described as trending east-west through the central part of LF-01, with the western half of the landfill on alluvium. The Santa Fe Formation is distinguished from alluvium by its greater degree of induration which is indicated by increased resistance to penetration testing. Lysimeter LF-01-01 was set in sandy alluvium material and lysimeter LF-01-02 was set in a clayey material that cannot be accurately assigned to either formation. Seismic refraction data have provided general information on the lateral and vertical extent of buried materials. These data indicate a variable fill thickness with a maximum of about 30 feet and have been summarized in the cross sections shown on Figure 1.4. The accuracy of the seismic data are 10 to 20 percent.

LF-02 lies on Tijeras Arroyo flood plain alluvium. The Santa Fe Formation occurs in the northern-most portion of LF-02 but its relationship to fill materials could not be accurately determined. Both lysimeters, LF-02-01 and LF-02-02 were set in sandy flood plain alluvium. Seismic data indicate fill thickness on the order of 20 feet (10 to 20 percent). Figure 1.7 presents a summary of the available data in cross section views of LF-01.

LF-03 straddles the geologic contact between the Santa Fe Formation and alluvium. The southern portion of LF-03 lies on alluvium and the northern portion lies on the Santa Fe Formation. Seismic refraction data indicate a maximum fill thickness of about 30 feet (±10 to 20 percent) in the southern-

most area. These data are summarized in the cross sections shown on Figure 1.10.

LF-04 lies largely on the Santa Fe Formation. Alluvium was encountered at the western end of the landfill and is thought to extend under the landfill. The thickness and extent of the alluvium deposits could not be determined with the existing data. Seismic refraction data indicate a maximum fill thickness of about 40 feet (10 to 20 percent). These data are summarized in the cross sections shown on Figure 1.13.

RB-11 lies entirely on the Santa Fe Formation. A comparison of the materials encountered in the two boreholes drilled at this site indicates the Santa Fe Formation undergoes profound changes in material types over short horizontal distances. Seismic refraction lines were run on three trench scars at RB-11 and indicate the trenches vary in depth from about 10 to 15 feet to a maximum of about 30 feet. These data are summarized in the cross sections shown on Figure 1.17.

The FTA lies entirely on the Santa Fe Formation. The only geologic data gathered for this site were from the shallow soil sampling program. These data indicate the central portion (under the cement pad) is dominated by a 22-foot thick lense of clay. This clay lense is elongated in the east-west direction and thinner in the north-south direction. This relationship is indicated in Figure 1.20. The interfingering shown in this figure is schematic and is inferred from the general characteristics of the Santa Fe Formation.

4.2 SIGNIFICANCE OF FINDINGS

Based on the results of the Phase IIB effort, the following general and site specific findings can be derived.

4.2.1 EXTENT OF CONTAMINATION

The degree to which contamination extent can be inferred from existing data is affected by the following factors:

- The lack of background data and the paucity of sampling points has restricted the degree to which the extent of contamination can be condidently inferred.

- Ground water contamination does not appear to be present based on a single sample analysis from each of two monitor wells down-gradient from LF-01 and LF-02. Additional sampling is needed to fully verify this preliminary observation.

- The depth to ground water is generally greater than 300 feet under the study sites. This vadose zone contains zones with as little as 2% natural moisture (Appendix I). Contaminant movement in the saturated zone would be northward from the landfill areas and would degrade KAFB production wells prior to reaching municipal wells. KAFB's water sampling program would detect this degradation should it occur.

- Landfills 1, 3 and 4 straddle parts of the alluvium/Santa Fe Formation contacts. The alluvium is less indurated (softer) than the Santa Fe Formation and, consequently, has the potential to provide a preferred flow path for infiltrating water. This relationship is particularly critical to the actual formation contact where a change in flow rate may contribute to the accumulation of soil moisture in one or both units. The verification of these relationships was beyond the scope of Phase IIB.

The extent of contamination was demonstrated for the FTA study area only. At this site a zone containing elevated oil and grease concentrations was located in an area coincident with the existing cement-covered pad. The elevated oil and grease values persist to a depth of at least twenty feet.

The extent of contamination at other Phase IIB study areas (LF-01, LF-02, LF-03, LF-04 and RB-11) is restricted to the delineation of landfill geometries (previously unknown). The nature and extent of contamination or the lack there of has not been clearly demonstrated due to the large area encompassed by the landfills relative to the low number of sample points.

4.2.2 EVALUATION OF CONTAMINATION

LF-01

- Soil moisture values encountered at lysimeter boring LF-01-02 indicate that the KAFB storm drain is contributing higher than normal line recharge in close proximity to LF-01. The storm drain channel is not underlain by landfill debris.

- Analyses of two soil samples collected at vertical depths of 49 ft. and 35 ft. beneath LF-01 showed less than 200 mg/kg oil and grease and no detectable scan pesticides or halogenated organics.

- Inorganic analyses for lead, sodium, and iron are not amenable to interpretation as these analyses were based on whole sample digestion and there exist no site-specific background data for comparison. Analyses by whole sample digestion has not allowed differentiation between that fraction of the sample which might be mobilized by infiltrating water and that portion which forms the insoluble mineral matrix.

- Cover conditions in the south central portion of LF-01 are poor and fill material is exposed to the environment.

LF-02

- The proximity of LF-02 to the active channel of Tijeras Arroyo and its location within the 100- and 500-year flood plains as defined by the U.S. Army Corps of Engineers may lead to erosion, headcutting or denudation of and subsequent surficial transport of the fill material. Surficial flow in response to normal precipitation events has introduced landfill material into the active channel of Tijeras Arroyo.

- Potential leakage from the portions of Tijeras Interceptor sewage line and the KAFB golf course transfer irrigation line would infiltrate through fill materials (when present).

- Surface ponding sink holes, dessication cracks, and soil piping, in conjunction with uncontrolled drainage from parts of the ARES and TRESTLE facilities, may contribute substantial volumes of runoff infiltration through the LF-02 landfill.

- Two soil samples collected from two locations at depths of 49 and 30 vertical feet below the estimated bottom of LF-02 did not show detectable levels of halogenated organics, pesticides or oil and grease. Total concentrations of lead, sodium and iron from total sample digestion cannot be used for analysis of potential migration from LF-02 for the reasons previously stated in LF-01.

LF-03

- Headcutting erosion of cover material on the south face of LF-03 will eventually expose fill materials.
- Detectable levels of halogenated organics, scan pesticides or oil and grease were not found in a single soil sample collected at a depth of 41 vertical feet below the estimated bottom of LF-03.

LF-04

- Headcutting erosion on the west face of LF-04 is starting to expose fill.
- LF-04 does not appear to have any substantive problems or evidence of evaluated soil moisture.
- Detectable levels of halogenated organics, pesticides or oil and grease were not found in a single soil sample collected 41 vertical feet below LF-04.

RB-11

- Soil moisture is low (less than 10%) to a depth of 100ft.
- No specific efforts were made to locate a 55-gallon drum of contaminated mercury reportedy buried here. This container should be located and disposed of in a proper manner. Soil samples analysis did not detect mercury or silver.
- Surface monitoring of cuttings for gamma radiation did not yield any readings in excess of normal background levels.
- No detectable levels of halogenated organics, pesticides, or oil and grease were found in a single soil sample collected 37 vertical feet below RB-11.
- Attempts to determine a location for the Sandia Fault (which occurs in the vicinity of RB-11) were unsuccessful and consequently the impact of this feature relative to contaminant transport could not be assessed.

DM Monitor Wells

- Both wells were completed in the upper 50 feet of the saturated ground water zone downgradient from LF-01 (DM-01) and LF-02 (DM-02).

- Single water samples from each well showed detectable levels of organic chlorine (0.02 mg/l and 0.01 mg/l for DM-01 and DM-02, respectively). DM-02 showed detectable organic bromine (0.004 mg/l). Neither well showed detectable levels of organic iodine or total organic carbon. Nitrate levels for DM-02 and DM-02 were 0.03 and 4.0 mg/l, respectively which are below regulatory standard of 10 mg/l. These data, although preliminary, indicate large scale degradation of the ground water has not occurred.

FTA

- Detectable levels of halogenated organic compounds (TOX) were found in 19 of the 30 soil samples collected adjacent to the cement pad. All 19 TOX values were within the range of background values.

- Oil and grease were detected in 12 of the 30 samples collected. Of the 12 positive analyses, four were in excess of background values.

- The analyses showing elevated oil and grease levels correspond to an area coincident with the existing cement pad. The vertical extent of oil and grease beneath the FTA is unknown, as elevated levels (1200 mg/Kg) were detected in the deepest sample (from 20').

- The extent and nature of any contamination associated with the ponding area south of the FTA was beyond the scope of Phase IIB.

5.0 ALTERNATIVE MEASURES

The following section describes the possible additional activities that could be implemented for each site. These activities are then grouped into several potential courses of action to be pursued under the authority of the IRP. The recommended program is discussed in Section 6.2.

Because of the generally large size of individual sites and the minimal number of sample points, it is not feasible to specify detailed remedial actions at this point. The presence of contamination, or absence thereof, has not been confirmed with a statistically defendable data base. Therefore, the proposed alternatives typically call for additional site evaluation efforts, as well as the monitoring of existing installations.

Some general concerns with regard to the existing data are listed below:

- A greater spatial distribution of points for soil sampling and analyses is needed beneath the fill/native soil interface to provide greater assurance of detecting the absence or presence of subsurface contamination.

- Slant hole drilling adjacent to the landfills provides limited lateral penetration into the zones directly beneath the fill. The uncertainty with regard to the actual lateral limits of each landfill results in an equivalent uncertainty as to the location of the soil or water samples collected. This leads to the general recommendation that future site evaluation be conducted via vertical borings penetrating fill materials to determine the status of contaminant migration under the landfill.

- The transport of contaminants by surface waters and shallow baseflows in Tijeras Arroyo has not been addressed in this effort. U.S. Environmental Protection Agency personnel have suggested additional soil sampling in the active channel and adjacent banks of Tijeras Arroyo. (Robinson, 1983, personal communication).

- Initial data indicate that the need for background data has not yet been demonstrated because no contaminants have been detected at the five landfill sites. This is not the case for the FTA where background data are available and some limits of contamination extent are discernable.

- The low soil moisture contents beneath the landfills suggest that infiltration occurs at a non-steady rate or as a pulsed response to intermittent precipitation and runoff, followed by gravity drainage. The rates and extent of such non-steady, unsaturated flows have not been examined in this study.

The specific alternative measures proposed for each landfill site need to be considered in light of the aforementioned general areas of concern. The following subsections provide specific additional tasks to be considered for each site.

All borings referenced below are for the purpose of characterizing potential migration conditions underneath each site. Fill materials are not scheduled for sampling. These borings are deemed necessary as the potential for contaminant migration at KAFB is largely vertical and the existing geochemical data are insufficient for environmental evaluation at the larger sites. The installation of these borings will require extensive safety precautions both before and during drilling as little is known of the character of the fill materials. These precautions should be developed by USAF OEHL and the preferred contractor(s). Additionally, backfill schedules for these borings should be rigorous and prevent the spread of contamination via the boreholes. The installation of sampling apparatus is not recommended at this time.

5.1 LF-01

- Establish long-term monitoring schedules for well DM-01. This program should include:
  - Quarterly (minimum) water level measurements with consideration given to installation of continuous water level measurement system.
  - Water quality monitoring-once or twice per year. Initial sampling to include Interim Primary and Proposed Secondary Drinking Water Standards as well as non-redundant Priority Pollutant and should be repeated every 6-8 sample events (3-4 years). Interim sampling should be performed 1-2 times per year with a reduced analyte list to be developed in conjunction with results of extended sampling and concurrence with agencies administering the KAFB area.
  - Coordinate DM-01 sampling schedule with sampling of DM-02 and KAFB production wells 2, 4, 7, and 8.
- Establish long-term schedule for monitoring lysimeters LF-01-01 and LF-01-02 for soil moisture on a quarterly basis. Consideration should be given to installation of automatic lysimeter sampling equipment so that intermittent subsurface infiltration would more likely be captured and labor requirements for monitoring could be reduced.

- Construct lined drainage (buried CMP or RCP) in open channel traversing LF-01. Option: regrade storm drain channel to remove debris and ponding areas and leave the channel open.

- Provide redressing of exposed debris and fill material in south central portion of LF-01. The objective is to remove potential ponding sites and cover exposed debris. This would also improve appearance of KAFB with respect to the flying public.

- Drill vertical boreholes, and submit soil samples (gathered at 5-foot intervals (maximum) to at least thirty feet below the native material/fill interface) for analyses of water-soluble TOX, oil and grease, volatile organics and selected inorganics. Appropriate protective clothing and respiratory protection should be worn by all on-site personnel.

5.2 LF-02

The two major considerations with respect to potential surficial and shallow subsurface environmental degradation for this site are the proximity of the site to the active channel of Tijeras Arroyo and poor surface drainage. The active channel of Tijeras Arroyo is of concern due to the nature of its flow which, when present, is typically a high velocity, short duration event in response to localized precipitation. LF-02 is located within the 100-year flood plain as well as in contact with the active channel making it suceptable to erosion by water. The poor surface drainage provides potential ponding sites for local precipitation and residual waters from flood events. These ponding sites enhance the potential for infiltration and overlie areas known to contain fill material. The degree to which these features have resulted in contaminant transport, either to ground water or to the downstream environment of Tijeras Arroyo, is unknown.

Additionally, the construction of the Tijeras Sewage Interceptor Line by the City of Albuquerque and the KAFB Golf Course Irrigation Pipeline on the north and east sides of LF-02 have obscured the boundaries of the fill area making precise determination of the fill boundaries in that area difficult.

- Establish long-term monitoring schedules for well DM-02. This program should include:

    - Quarterly (minimum) water level measurements with consideration given to installation of continuous water level measurement system.

    - Water quality monitoring-once or twice per year. Initial sampling to include Interim Primary and Proposed Secondary Drinking Water Standards as well as non-redundant Priority Pollutants and should be repeated every 6-8 sample events (3-4 years). Interim sampling should be performed 1-2 times per year with a reduced analyte list to be developed in conjunction with results of extended sampling and concurrence with agencies administering the KAFB area.

    - Coordinate DM-02 sampling schedule with sampling of DM-01 and KAFB production wells 2,4,6,7 and 8.

- Establish long-term monitoring schedule for lysimeters LF-02-01 and LF-02-02 on a quarterly basis with consideration given to installing an automatic sampling system.

- Provide additional surface geophysical surveys to further delineate LF-02 lateral limits.

- Conduct a more thorough aerial photo archival study of off base photogrammetry services to supplement the geophysical survey data for boundary locations. Sources for additional historic aerial photo searches should include local private photogrammetric service organizations and federal agencies.

- After completion of additional landfill boundary determinations, conduct additional drilling through the LF-02 fill to collect soil samples directly below the fill/native soil interface to a depth of at least 30 feet below the interface. Soil samples should be collected at five foot intervals (maximum) with analysis for water-soluble TOX, oil and grease, volatile organics and selected inorganics. This effort would characterize the status of contaminant migration under LF-02.

- Determine the availability of detailed topographic survey data in the LF-02 and TRESTLE/ARES facilities area to provide for appropriate drainage of the LF-02 surface and adjacent areas.

- After obtaining appropriate detailed elevation control and more precise boundary locations, design and implement a comprehensive top dressing and drainage plan for the LF-02 area.

- Conduct additional drilling and soil sampling in the active channel section of Tijeras Arroyo to a depth of at least twenty feet in both an upstream and downstream direction from LF-02. Approximately five borings upstream, five borings adjacent to, and five borings downstream of LF-02 should be conducted. Samples should be analyzed for water-soluble TOX, oil and grease, volatile organics, and selected inorganics and would provide data on the status of contamination in Tijeras Arroyo. The upstream borings are recommended as background data will be required for environmental degradation analyses due to the existance of at least one municipal landfill in Tijeras Arroyo, upstream of LF-02.

5.3 LF-03

- Monitor lysimeter LF-03-01 on a quarterly basis. Consideration for automated lysimeter sampling should be postponed until the effectiveness of continuous automated lysimeter sampling is established at LF-01 or LF-02.

- Provide periodic inspections of the south face of LF-03 for development of rills or gullies that would expose fill material.

- Drill an additional boring through LF-03 fill material and sample soils at 5-foot intervals (maximum) to a depth of at least 30 feet below the fill/native soil interface for analysis of TOX, oil and grease, volatile organics, and selected inorganics.

5.4 LF-04

- Monitor lysimeter LF-04-01 on a quarterly basis and postpone consideration of installing automated sampling until effectiveness of LF-01 or LF-02 automated sampling can be demonstrated.

- Drill vertical borings through the fill and sample native materials at 5-foot intervals (maximum) to a depth of at least 30 feet below the interface and analyze for water-soluble TOX, oil and grease, volatile organics and selected inorganics.

- Provide periodic inspection of the west face of LF-04 to monitor for erosion and exposure of fill material. The west face of LF-04 should be redressed concurrently with closure of LF-06.

5.5 RB-11

The RB-11 site has presented a unique situation in comparison to the other sites from both a physiographic and waste disposal practice perspective. The reported wastes in RB-11 vary from a large volume of irradiated laboratory animal carcasses to minute ammounts of toxic liquid wastes. Additionally, the reported disposal of a drum of mercury (DeBoer, 1983 personal communication) is a cause of concern. The site is not directly exposed to erosion or enhanced surface water infiltration. The single lysimeter boring soil sample has not indicated the presence of detectable TOX, oil and grease or pesticides. It is unknown to what extent any of the different types of waste were segregated to the trenches. Because of the numerous uncertainties regarding this site, the alternatives presented are broad ranging and allow greater latitude in options for continued investigation.

- Monitor lysimeter RB-11-01 in the event that soil moisture movement is of seasonal or episodic nature.

- Perform a magnetometer survey over the trench scars in order to locate the reported drum of mercury. Once located, the drum should be removed with appropriate protection for all personnel involved.

- Initiate additional angled drilling between trenches with targeted completion five to ten feet below the bottom of the trenches. Because the lateral limits of the RB-11 trenches can be more accurately determined, it is felt that angled holes will have a greater probability of being targeted accurately than in the case of the larger landfill sites. Sample soils at maximum intervals of 5, 10, 15, 20 and 30 feet along the angled borehole length. Samples should be analyzed for alpha, beta, and gamma radiation activity, cyanide, mercury, silver and volatile organics at the minimum. The exact number and location of these borings should be determined after additional interviews with personnel involved with the operations at RB-11 and the magnetometer survey.

- Should additional soil analyses prove uncontaminated, discontinue monitoring of lysimeter RB-11-01 due to the low moisture encountered at this boring.

- Seal the surface of RB-11 trenches with compacted clay, asphalt or concrete to prevent infiltration of surface waters.

- Locate and seal another trench reported (DeBoer, 1983, personal communication) west of the RB-11 area.

5.6 FTA

The detection of oil and grease in soil samples at the FTA indicate vertical migration of fuel or waste oil beneath the site. The depth to which this migration has occurred can only be speculated. The oil and grease peak concentration occurred at 15 feet and was diminished at 20 feet (FTA-10), which suggests limited vertical migration. It is likely that the migration has been diminished since lining of the pad about eight years ago (ESI, 1981). The pipe line which drains the pad to the unlined ditch east of the pad has reportedly not been used. Evidence of petroliferous residues in a drainage ditch outfall southwest of the FTA suggest that either the FTA has drained to this ditch or that other source areas (drainage from north of Albuquerque International Airport) have contributed to the observed residues at the ditch outfall. Therefore, the alternatives for the FTA are directed toward additional assurances of containment of fuel and oil sources.

- Patch and seal the pad area with water-tight materials to provide greater assurance of liquid containment on the pad.
- Construct a larger curb or berm around the pad to contain fuel materials.
- Eliminate or plug the drain line to the drainage ditch east of the FTA.
- Provide for pressure testing of the JP-4 fuel lines to detect fuel leaks.
- Provide for storage volume monitoring in the JP-4 fuel tank and meter flow to sprinklers in order to provide inventory control on fuel storage/use at the FTA.
- Provide additional drilling and sampling in the FTA area to verify the vertical extent of fuel/oil migration directly below the pad.
- Conduct additional drilling and soil sampling in the drainage ditch east of the FTA and the outfall area southeast of the FTA to determine the extent to which storm drainage has contaminated these areas.
- Determine potential source areas for other drainage outfall southeast of the FTA to determine if present or historical use of this second drainage may have contributed to the observed petroliferous residue.

5.7 PROGRAM ALTERNATIVES

The following alternatives are recommended for pursuit under the authority of the IRP and are prioritized from best possible choice (Alternative I) on down. Please note that Alternative I is highly recommended as the alternative of choice and has been selected by the Air Force for implementation. Please note, however, that all alternatives outlined below include the longterm monitoring of existing KAFB production wells and the monitoring sites established under Phase IIB. This monitoring is essential to the definition of existing conditions regarding contaminant migration and would identify any future aquifer degradation in a timely manner. The IRP does allow for this necessity and funding should be obtained for the establishment and maintenance of a program of this nature.

5.7.1 Alternative I

This option is based on the following characteristics of the KAFB area which heavily influence the selection of this option as the alternative of choice.

A. KAFB is located in the arid southwest and receives an average of 8.4 inches of precipitation per annum. Thus the potential for continuous vertical contaminant transport by water is lower than that for other climes.

B. The vadose zone is typically greater than 300 feet thick under KAFB and SAI has documented zones containing as little as 2% soil moisture in the upper portions of this unit. These data indicate a low probability of saturated connection between the study areas and the water table.

Under this option Phase II would be terminated as it stands at present. The KAFB IRP would then proceed with a program directed toward the location and removal of a 55-gallon drum of mercury reportedly buried at RB-11 and the redressing of LF-02 as described under Alternative II. All other study areas would be closed. Water level and water quality monitoring should be implemented at selected KAFB production wells and the monitoring wells (DM-01) and DM-02) constructed under Phase IIB. Should the KAFB IRP choose this option it should be noted that the existing data base does not conclusively show the presence or absence of contamination at all study areas or in the ground water. However, it does appear that large scale contaminant migration has not occurred as the result of KAFB waste disposal practices.

5.7.2 Alternative II

Based on the data gathered during Phase IIB, this alternative would be initiated at KAFB in order to substantiate the Phase IIB findings. This proposed Phase IIC would address LF-01, LF-02, and RB-11. LF-01 and LF-02 cover large areas and have four geochemical data sites at the periphery of each landfill. Additional drilling and soil sampling are required for further characterization of contamination extent and nature. This drilling should penetrate fill materials with the objective of sampling native materials at 5-foot (maximum) intervals below the fill bottom to a total depth of 50 to 70 feet below ground surface. All soil analyses should be performed for water-extractable analytes (where applicable) which should include, but not be restricted to, oil and grease, TOX, and the physical properties of soil moisture, density, grain size distribution, and specific retention. These data will determine the degree of remedial activity required. Should these data indicate the absence of contamination, the following activities are recommended for pursuit under Phase IV of the IRP.

At LF-01 the storm runoff channel should be cleared of debris and potential ponding areas. In addition, scattered debris should be consolidated in an area not affected by the storm drain and covered.

At LF-02 the portion of the landfill in contact with Tijeras Arroyo should be stabilized with appropriately sized riprapping and filler blanket. The surface of the landfill should be redressed to eliminate potential infiltration areas and provide controlled drainage from the TRESTLE & ARES facilities.

At RB-11 it is recommended that a magnetometer survey be performed in order to locate the reported 55-gallon drum of mercury. This locating process should be pursued under the proposed Phase IIC with actual drum removal and site restoration performed under Phase IV.

Under this option the study of LF-03 would be terminated as it stands by virtue of its small size, the nature of materials reportedly buried there and site setting characteristics. Additionally, LF-04 studies would be terminated by virtue of the site characteristics. The erosion of cover material at the western face of LF-04 may be rectified coincidentally with the closure of LF-06 at some unknown point in the future.

All the recommendations above should be carried out in conjunction with long-term monitoring of selected KAFB production wells and those sampling sites established during Phase IIB. The study of the remaining sites (FTA, LF-03, LF-04) would be considered closed.

5.7.3 Alternative III

Include those activities indicated in Alternative I and perform additional geochemical soil analyses at LF-04 and the FTA. The FTA effort should consist of the drilling and sampling of a borehole in the area of boring FTA-10 to a maximum depth of 100 feet. This effort would identify the lower limit of oil and grease contamination. Consideration should be given to the computer modeling of transit times at the FTA based on the additional data. In addition, the FTA sprinkler and pressure tank would be pressure tested, fuel inventory monitored closely, and the pad resealed as well as the

drain line plugged. Under this alternative LF-04 would be further investigated with the drilling and sampling of several boreholes in the central and eastern portions of the landfill. This drilling would target the first 30 feet of native materials under the fill. These additional investigations at LF-04 can be coordinated with the LF-06 closure. LF-03 would be considered closed with respect to the KAFB IRP.

5.7.4 Alternative IV

In addition to the activities outlined under Alternatives I, II, and III, the following actions would be considered as follow-on efforts unrelated to the other alternatives. These actions can be considered at any time and are not related to the selection of Alternative I, II, and/or III. The major activities in this category are as follows:

A. Initiate appropriate study of the Tijeras Arroyo as a system because the effects of LF-02 cannot be properly assessed without background data due to the presence of an abandoned City of Albuquerque landfill approximately two miles upstream. Downstream investigations are necessary to document the presence or absence of contaminant transport into populated areas. The computer modeling of subsurface transport phenomena is recommended to provide an estimate of travel times based on local conditions. This computer modeling will require the acquisition of specific field data to be used as input. Initiate appropriate field sampling to define the potential contaminants in the Tijeras Arroyo upstream, adjacent to and downstream of LF-02, and to evaluate the potential impact.

B. The other recommended action would be to search the literature to locate and define mathematical modeling programs that would predict contaminant transport times under unsaturated conditions in stony soils. The model would then be applied to all study sites as applicable.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

6.1.1 LANDFILL NUMBER 1 (LF-01)

- The storm drain that crosses the site is a contributing factor to the relatively elevated moisture contents encountered during drilling.

- Although preliminary sampling showed no detectable indication of contamination, addition geochemical data are required to assess the status of this 53-acre site.

6.1.2 LANDFILL NUMBER 2 (LF-02)

- The various cover irregularities (soil piping structures, drainage ditches, and sink holes) on the northern portion of the landfill provide the greatest potential for increasing soil moisture by the infiltration of surface water.

- The effects of Tijeras Arroyo could not be assessed with the data in-hand. The active channel of Tijeras Arroyo is in contact with the south boundary of LF-02 and requires additional investigation before an assessment of impact can be provided. However, erosional degradation of the southern limit of LF-02 due to surface flows in Tijeras Arroyo can be anticipated.

- Field investigations have not adequately characterized the landfill boundary conditions immediately south of the TRESTLE facility.

- Although preliminary sampling showed no detectable indication of contamination, additional geochemical data are required to characterize the status of potential contamination at this 32-acre site.

6.1.3 LANDFILL NUMBER 3 (LF-03)

- This site does not appear to be degrading the environment. However, this opinion should be verified by at least one additional borehole and associated sampling.

6.1.4 LANDFILL NUMBER 4 (LF-04)

- Although preliminary sampling showed no detectable levels of indicator parameters, additional sampling points should be required to characterize this site.

6.1.5 RADIOACTIVE BURIAL SITE NUMBER 11 (RB-11)

- There is no evidence of degradation of the surficial environment due to the release of radioactive decay products.
- Buried materials were placed in at least 9 separate trenches. Sampling performed at this site addressed only one trench. Additional sampling is required before a definitive conclusion as to the status of contamination extent, if any, can be reached.
- There is a high probability that a 55-gallon drum of mercury is buried in one of the trenches. This is based on the vividness of the interviewee's recollections of the incident.

6.1.6 FIRE CONTROL TRAINING AREA (FTA)

- The area immediately below the concrete pad shows contamination by oil and grease to a depth of twenty feet. This contamination is confined to the area of the concrete pad and reaches a maximum reported value of 6500 mg/kg at fifteen feet. All halogenated organic (TOX) analyses are within the range of background values.
- No conclusions can be reached with respect to the ponding area south of the site or the storm drain channel.

6.2 RECOMMENDATIONS

The following general areas of activity are recommended for pursuit under the IRP format. These activities can be classified as addressing the following areas:

- The long-term monitoring of Phase IIB installations and selected KAFB production wells for geochemical and physical data.
- Data acquisition to augment the existing database for selected study areas.
- Remedial actions.

Where justified, the termination of IRP activities are indicated.

These recommendations are summarized in Table 1 (Executive Summary).

6.2.1 LONG-TERM MONITORING

A long-term ground water quality monitoring program should be implemented at KAFB. This monitoring program would characterize the quality of ground

water in light of the expanded analytes of concern and would identify water quality degradation in its early stages. This monitoring program should include wells DM-01 and DM-02 and KAFB production wells 2, 4, 6, 7 and 8 which are located within one mile of Phase IIB study areas. These wells (especially DM wells) would be the first wells to degrade should contamination be detected.

It is recommended that these wells be sampled on an annual or semi-annual (twice per year) basis. The initial analyses should include the Interim Primary and Proposed Secondary Drinking Water Standards and the nonredundant Priority Pollutants. After this initial rigorous analytical schedule, a reduced number of analytes can be selected for normal sampling and analyses. However, as a periodic verification, the more extensive list of parameters from the above analyte schedule should be included in the regular monitoring program. This monitoring program would provide a survey of the quality of ground water at KAFB in light of recent concerns and would provide an economical means of identifying and/or monitoring potential ground water degradation. Water level measurements should be included in this monitoring in order to document changes in the altitude of the water table.

Vacuum lysimeters should be monitored quarterly for a period of two to five years with emphasis on LF-01 and LF-02. Attempts should be made to coordinate sampling events with periods of higher precipitation. Should liquid samples be obtained, the analyses performed should include, but not be restricted to, the following: total organic halogen scan, oil and grease, total lead, total iron, total sodium, and a pesticide scan (similar to that used for this Phase IIB study). All sampling efforts must be formally documented. A consideration should be given to installing an automatic vacuum pump system on at least one or two lysimeters so that sample collection could be made more assured in the event that moisture transport is rapid after precipitation events. This monitoring will provide two essential types of data:

- Should liquid samples not be generated, it could be inferred that there is not sufficient moisture for contaminant transport.

- Should liquid samples be generated, the recommended analyte schedule should serve to quickly identify the presence of contamination, which could then be acted upon in a timely manner.

In addition to monitoring for soil moisture, it is strongly recommended that provisions be made to sample the soil gasses which are accessable with the vacuum lysimeters. This soil gas sampling should be performed quarterly for two to three years to establish a basis for comparison and identify seasonal effects. This soil gas sampling should address the more volatile contaminants such as halogenated compounds, solvents, hydrocarbons and aromatics as well as major gasses. Again, all sampling efforts must be formally documented.

All future drilling activities directed toward developing or testing the water table should be geophysically logged prior to completion. This borehole logging should, at a minimum, consist of the following data sets: spontaneous potential logging, resistivity, calibrated neutron and gamma-ray logging. Borehole geophysical logs are recommended as they provide a continuous record of formation characteristics such as lithology, moisture content and total porosity which are determined by the materials encountered in the borehole and would document the character of the vadose zone which is the major barrier to downward contamination migration. The suite of logs recommended are commonly used in water resource investigations and are standard within the borehole logging industry. These data, would contribute greatly to the general geologic and hydrologic understanding of the KAFB-Albuquerque area, as well as supplementing the KAFB/IRP data base.

6.2.2 ADDITIONAL DATA ACQUISITION

Some of the data acquisition efforts indicated below require the penetration of areas known to contain fill materials. The nature of these materials is unknown at this point in time and it is unlikely that these materials can be identified via literature or geophysical testing. The nature and history of KAFB activities does not preclude existance of exotic materials or relatively common items that have become environmental concerns. These factors dictate that precautions for personal safety be adopted for the drilling activities. In general, these precautions involve the pre-drilling

remote sensing of drilling sites with siesmic and/or gravimetric techniques to identify large, dense objects as well as extensive personal protection during drilling and onsite monitoring for hazardous volatiles during drilling. The exact nature and extent of these precautions should be determined by the preferred contractors in conjunction with the USAF/OEHL prior to field activities. In conjunction with the safety program above, rigorous backfill schedules are required to prevent the spread of contaminants via the boreholes.

LF-01

Additional soil sampling should be conducted. This effort should address sampling for background data and the sampling of the first thirty feet of native material below the landfill bottom. The sampling that addresses native materials below the landfill will require that boreholes penetrate fill and will consequently require substantial personal protection for all on-site personnel and the other measures indicated above. A written safety plan should be required prior to the initiation of drilling. This sampling is recommended to fulfill the ultimate objectives of Phase II namely, problem confirmation and quantification. The status of subsurface conditions at this 53-acre site can neither be characterized nor quantified with the existing data.

LF-02

Additional sampling and boundary definition efforts should be conducted at this site. The sampling effort should address the acquisition of background geochemical data and characterization of the first thirty feet of native materials below the landfill bottom. The sampling that addresses the native materials under the landfill will require that boreholes penetrate areas known to contain fill and will consequently require substantial protection for all on-site personnel as well as the measures indicated above. A written safety plan should be required prior to the initiation of drilling. This sampling is recommended to fulfill the ultimate objectives of Phase II namely, problem confirmation and quantification. The geochemistry of this 32-acre site can neither be characterized nor quantified with the data in hand.

The additional boundary determination efforts should be directed to the central and northern portions of the landfill. This effort should consist of a search for and analysis of aerial images from off-base sources and additional profiling by surface geophysical prospecting. This investigation may provide a basis for reducing the areal extent of LF-02 and should be conducted prior to drilling activities.

LF-03

The acquisition of additional data for LF-03 is not recommended because it is well located and well covered, has low soil moisture values and shows no detectable indicator analytes. The existing lysimeter is well located and there are few alternate sampling points.

LF-04

Additional sampling should be conducted at this site. This sampling effort should address the acquisition of background geochemical data and characterization of the first thirty feet of native material below the landfill bottom. The sampling that addresses the native materials under the landfill will require that boreholes penetrate areas known or thought to contain fill and will require full personal protection during drilling and other measures described above. This effort will provide additional site characterization data although it is not known if the recommended sampling will suffice.

FTA

The acquisition of additional data for the FTA is not strongly recommended. The presence of oil and grease has been confirmed to a depth of 20 feet below the cement pad. If additional data acquisition is desired, the work should define the lower limits of the oil and grease. Should modeling of transport phenomena be pursued, additional field data may be required to calibrate the model.

RB-11

Additional sampling should be conducted at this site. This sampling effort should address the acquisition of subsurface geochemical data at

specific, known trench sites and background data. It is recommended that angled drilling be performed between the trenches and sampling be directed at characterizing of the first 30 feet of native material below the trench bottoms. The analytes for this sampling effort should be expanded to include alpha, beta and gamma activity, cyanide, mercury and silver. In addition, a magnetometer survey should be conducted in order to locate a reportedly buried drum of mercury.

6.2.3 REMEDIAL ACTIONS

The following remedial actions are considered necessary even if the additional data acquisition efforts are not implemented. Should the additional data demonstrate significant environmental contamination, the schedules below would be expanded and modified accordingly.

LF-01

Regardless of the results of additional sampling and analyses, the storm drainage that crosses LF-01 should be cleared of debris and potential ponding areas. This drainage should be lined with a low permeability material or routed through a conduit. In addition to drainage modifications, the scattered debris in the south-central area of LF-01 should be stockpiled well away from the storm channel and covered.

LF-02

Remedial actions proposed for this site are conditional on the results of the additional data acquisition efforts described in Section 6.2.2 in order to preclude potential duplication of efforts. Should this sampling indicate little or no subsurface contaminant migration it is recommend that data acquisition and design analyses be initiated to address the rip-rapping of the LF-02/Tijeras Arroyo contact and redressing of the landfill surface (and nearby environment). This would facilitate controlled drainage away from the landfill and minimize the impact of potential flooding events in Tijeras Arroyo.

LF-03

No remedial action other than monitoring for erosion and headcutting into this fill site are recommended.

LF-04

Redress the western slope of the landfill where erosion in exposing fill materials. This effort should be carried out in conjunction with the closure of LF-06.

RB-11

Should a surface magnetometer survey locate the reportedly buried drum of mercury, said drum should be recovered and disposed of via DRMO and the site reclaimed. These efforts will require full body coverings and may require self-contained breathing apparatus as the decaying carcasses are probably noxious.

FTA

Install a system to monitor fuel consumption and perform annual pressure checks of the fuel tank and sprinkler system in order to document the system's integrity. Sealing the asphalt surface, construction of beams or curbs around the pad and plugging of the drainage pipeline are also recommended for this site.

APPENDIX A

DEFINITIONS AND UNITS OF MEASUREMENTS

AF: Air Force

AFB: Air Force Base

AFR: Air Force Regulation

AFSC: Air Force Systems Command

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring

BIOACCUMULATE: Tendency of elements or compounds to accumulate or build up in the tissues of living organisms when they are exposed to these elements in their environments, e.g., heavy metals

BGS: Below ground surface

CERL: Construction Engineering Research Laboratory

CES: Civil Engineering Squdron

CLOSURE: The completion of a set of rigidly defined functions for a hazardous waste facility no longer in operation

CMP: Corrugated Metal Pipe

COD: Chemical Oxygen Demand, a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water

CONTAMINATION: The degradation of natural water quality to the extent that its usefulness is impaired; there is no implication of any specific limits since the degree of permissible contamination depends upon the intended end use or uses of the water

Det: Detachment

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water

DOD: Department of Defense

DOWNGRADIENT: In the direction of lower hydraulic head; the direction in which ground water flows

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics; dumps are susceptible to open burning and are exposed to the elements and scavengers

DRMO: Defense Reutilization and Marketing Office

EFFLUENT: A liquid waste discharge from a manufacturing or treatement process, in its natural state, or partially or completely treated, that discharges into the environment

EPA: Environmental Protection Agency

EROSION: The wearing away of land surface by wind or water

FACILTIY: Any land and appurtenances thereon and thereto used for the treatment, storage and/or disposal of hazardous wastes

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year

FLOW PATH: The direction or movement of ground water and any contaminants that may be contained therein, as governed principally by the hydraulic gradient

FTA: Fire Training Area. Equivilant to Fire Control Training Area.

GROUND WATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure

GROUND WATER RESERVOIR: The earth materials and the intervening open spaces that contain ground water

HALF-LIFE: The time required for half the atoms present in radioactive substance to disintegrate

HARDFILL: Construction debris, wood, miscellaneous spoil material

HAZARDOUS WASTE: A solid, liquid or gaseous waste, or combination of such waste, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly incapacitating reversible illness; or pose a substantial present or potential hazard to a human health or the environment when improperly treated, sorted, transported, disposed of, or otherwise managed.

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations

HQ: Headquarters

INCOMPATIBLE WASTE: A waste unsuitable for comingling with another waste or material because the comingling might result in generation of extreme heat or pressure, explosion or violent reaction, fire, formation of substances which are shock sensitive, friction sensitive, or otherwise have the potential for

reading violently, formation of toxic dusts, mists, fumes, and gases, volatilization of ignitable or toxic chemicals due to heat generation in such a manner that the likelihood of contamination of ground water or escape of the substance into the environment is increased, any other reaction which might result in not meeting the Air, Human Health, and Environmental Standards

INFILTRATION: The flow of liquid through pores or small openings

INWS: Interservice Nuclear Weapons School

IRP: Installation Restoration Program

KAFB: Kirtland Air Force Base

KFD: Kirtland Fire Department

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water

LEACHING: The process by which solube materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water

LF: Landfill

LINER: A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate

LWDS: Liquid Waste Disposal System

MONITORING WELL: A well used to measure ground water levels and to obtain samples

MSL: Mean Sea Level

MAC: Military Airlift Command

NMEID: New Mexico Envionmental Improvement Division

OEHL: Occupational and Environmental Health Laboratory

ORGANIC: Being, containing or relating to carbon compounds especially in which hydrogen is attached to carbon

PCB: Polychlorinated Biphynyls are highly toxic to aquatic life; they persist in the environment for long period and are biologically accumulative

PERCOLATION: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil

pH: negative logarithm of hydrogen ion concentration

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose

RB: Radioactive Burial Site

RCP: Reinforced Concrete Pipe

RCRA: Resource Conservation and Recovery Act

RECHARGE: The addition of water to the ground water system by natural or artificial processes

RECHARGE AREA: An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes environmental hazards

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process which also produces an upgraded liquid

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant ,w water supply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining or agricultural operations and, from community activities, but does not include solid or dissolved materials in domestic waste; solid or dissolved materials in domestic waste; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as ammended (86 USC80); or source special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923)

SPILL: Any unplanned release or dishcarge of a hazardous waste onto or into the air, land, or water

STORAGE OF HAZARDOUS WASTES: Containment, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such hazardous waste

TAC: Tactical Air Command

TOX: Total Organic Halogens-scan for organic bromide, organic chloride and organic iodide.

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism

TRANSMISSIVITY: The rate of which water is transmitted through a unit width under a unit hydraulic gradient

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition or any hazardous waste so as to render the waste nonhazardous

USACOE: United States Army Corp of Engineers

USAF: United States Air Force

USAF OEHL: United States Air Force Occupational and Environmental Helth Laboratory

VADOSE ZONE: That area below the ground surface and above the water table

WATER TABLE: Surface of a body of unconfined ground water at which the pressure is equal that of the atmosphere

APPENDIX B

Scope of Work

INSTALLATION RESTORATION PROGRAM
PHASE II FIELD EVALUATION
KIRTLAND AFB NM

83 Sep 14

I. DESCRIPTION OF WORK:

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at Kirtland AFB NM; to determine if hazardous chemical vapors are migrating and causing exposure of base personnel to concentrations of chemicals which are hazardous to their health; to make recommendations for actions necessary to fully evaluate the magnitude and extent of contamination should contamination be found; where possible to make recommendations for actions necessary to mitigate adverse environmental effects of existing contamination problems; to prioritize necessary remedial action efforts; to suggest potential ways of restoring the environment to as normal a level as is practical; and to suggest a future environmental program to document conditions and future discharges at sites identified at Kirtland AFB NM.

The presurvey report (task order 20) report incorporated background and description of the sites for this task. To accomplish the survey effort the following steps will be taken.

A. Review the final Phase I IRP Report (mailed under separate cover) and obtain a thorough understanding of the findings and subsequent recommendations made by the authors of the report.

B. Review all available literature and records on the characteristics, geology, and hydrogeology of each site discussed below.

C. Perform a reconnaissance and prepare a surficial map of each site discussed below.

D. Landfill No. 1

1. Perform a seismic survey to determine the vertical and lateral extent of the landfill boundaries.

2. Install an exploratory boring to a depth of 100 ft. Collect soil samples, using a split-spoon sampler, at 5- to 10-foot intervals and analyze for moisture content, specific retention and density. This hole and the following two boreholes shall be logged by an on-site geologist.

3. Install two 45° slant holes to a length of 100 feet. Emplace a Teflon® vacuum lysimeter in each slant hole.

4. Collect one sample from each lysimeter, using procedures outlined in the Phase II Presurvey Report. Analyze the samples for parameters indicated in Attachment 1.

(Modification highlights are underscored)

E. Landfill No. 2

1. Perform a seismic survey to determine the vertical and lateral extent of the landfill boundaries.

2. Install an exploratory boring to a depth of 100 feet. Collect soil samples, using a split-spoon sampler, at 5- to 10-foot intervals and analyze for moisture content, specific retention and density. This hole and the following <u>two</u> boreholes <u>shall</u> be logged by an on-site geologist.

3. <u>Install two 45° slant holes to a length of 100 feet. Emplace a Teflon vacuum lysimeter in each slant hole</u>.

4. Collect one sample from each lysimeter, using procedues outlined in the Phase II Presurvey Report. Analyze the samples for <u>parameters indicated in Attachment 1</u>.

F. Landfill No. 3

1. Perform a seismic survey to determine the vertical and lateral extent of the landfill boundaries.

2. Install an exploratory boring to a depth of 100 feet. Collect soil samples, using a split-spoon sampler, at 5- to 10-foot intervals and analyze for moisture content, specific retention and density. This hole and the following <u>borehole</u> <u>shall</u> be logged by an on-site geologist.

3. <u>Install one 45° slant hole to a length of 100 feet. Emplace a Teflon vacuum lysimeter in the slant hole</u>.

4. Collect one sample from <u>the</u> lysimeter, using procedures outlined in the Phase II Presurvey Report. Analyze the samples for <u>parameters indicated in Attachment 1</u>.

G. Landfill No. 4

1. Perform a seismic survey to determine the vertical and lateral extent of the landfill boundaries.

2. Install an exploratory boring to a depth of 100 feet. Collect soil samples, using a split-spoon sampler, at 5- to 10-foot intervals and analyze for moisture content, specific retention and density. This hole and the following boreholes will be logged by an on-site geologist.

3. <u>Install one 45° slant hole to a length of 100 feet. Emplace a Teflon vacuum lysimeter in the slant hole</u>.

4. Collect one sample from <u>the</u> lysimeter, using procedures outlined in the Phase II Presurvey Report. Analyze the samples for <u>the parameters indicated in Attachment 1</u>.

H. Radioactive Burial Site No. 11

1. Perform a seismic survey to determine the vertical and lateral extent of the burial site boundaries.

2. Install an exploratory boring to a depth of 100 feet. Collect soil samples, using a split-spoon sampler, at 5- to 10-foot intervals and analyze for mositure content, specific retention and density. This hole and the following borehole shall be logged by an on-site geologist.

3. Install one 45° slant hole to a length of 100 feet. Emplace a Teflon vacuum lysimeter in the slant hole.

4. Collect one sample from the lysimeter, using procedures outlined in the Phase II Presurvey Report. Analyze the samples for the parameters indicated in Attachment 1.

5. Prior to installation of the lysimeter, the U.S. Air Force will perform a radiological survey by lowering a gamma probe down the borehole. Any significant findings will be included in the final report referenced below.

I. Fire Training Area

1. Install ten boreholes; nine shall be installed in a three by three grid outside the concrete pad, and one at a distance of approximately 200 yards from the pad. The boreholes shall be ten feet deep, with samples obtained by split spoon at depths of 1, 5 and 10 feet.

2. Analyze the 30 soil samples by water extraction for the parameters indicated in Attachment 1.

J. Monitoring Wells

1. A maximum of two groundwater monitoring wells shall be installed during this task. The wells shall be emplaced along the western base boundary, downgradient of Landfills 1 and 2 and the Fire Training Area. Exact location of the wells shall be determined in the field. Each well shall be installed to a depth of ten feet below the lowest seasonal groundwater table. The wells shall be cased using Schedule 80 PVC (threaded joint) with 50 feet of PVC well screen. Well installation shall be accomplished using mud rotary or reverse mud rotary equipment. A maximum total depth of 1500 feet of well shall be installed.

2. One groundwater sample shall be obtained from each well and analyzed as specified in Attachment 1.

K. Surveying

Upon completion of the drilling, lysimeter and well installations, the locations of all lysimeters and wells shall be surveyed to a coordinate system wih locally available benchmark control. Additionally, the perimeter location of the landfill boundaries shall be staked and surveyed. Such boundary survey

may also include a meets and bounds description of the circumference limits of the landfills with appropriate permanent benchmark controls set in the field to allow later boundary identification. The boreholes and landfill areas shall be identified and tied into the base grid system.

L. Cleanup

Borehole locations will be cleaned following completion of the work by general policing of the area, with removal of cuttings if specified by Kirtland AFB officials.

M. Data Review

Results of sampling and analyses will be tabulated and forwarded to the USAF OEHL for review as soon as they become available as specified in Item VI below. A data review meeting may be held at the offices of SAI in Albuquerque NM prior to preparation of the draft report.

N. Report Preparation

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. This report shall include a discussion of the regional hydrogeology, well logs of all projects wells, data from water level surveys, water quality analysis results, seismic survey results and maps, available geohydrologic cross sections, groundwater surface and gradient vector maps, any available vertical and horizontal flow vectors and Laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. Estimates shall be made of the magnitude, extent and direction of movement of contaminants discovered. Potential environmental consequences of discovered contamination must be identified. Where survey data are insufficient to properly determine or estimate the magnitude, extent and direction of movement of discovered contaminants, specific recommendations, fully justified, shall be made for additional efforts required to properly evaluate contamination migration and included in a separately bound appendix to the draft final report (see O below).

3. Specific requirements if any for future groundwater and surface water monitoring must be identified.

O. Cost Estimates

Detailed cost estimates for all additional work recommended to properly determine or estimate the magnitude, extent and direction of movement of discovered contaminants at sites being investigated shall be provided along with an estimate of the time required to accomplish the proposed effort. This information shall be provided in a separately bound appendix to the final report.

ATTACHMENT 1

Analytical Parameters

Parameter (In Soils)	Landfill No. 1	2	3	4	RB-11	FTA	QA**	Total
TOX	2	2	1	1	1	30	5	42
Oils and Greases	2	2	1	1	1	30	5	42
Lead	2	2	1	1	1		1	8
Silver					1			1
Mercury					1			1
Sodium	2	2	1	1	1		1	8
Iron	2	2	1	1	1		1	8
Pesticides*	2	2	1	1	1		1	8

Parameter (In Water)***	Total
TOC	2
TOX	2
NO_3	2

Sampling, holding time and preservation methods for samples shall strictly comply with the following references: Standard Methods for the Examination of Water and Wastewater, 15th Ed. (1980), pp 35-42; ASTM, Part 31, pp 72-82, (1976), Method D-3370; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp xiii to xix, (1979). Minimum detection limits for analyses are shown in Attachment 2.

*Pesticide scan for 2,4-D, 2,4,5-T, DDT isomers, aldrin, lindane, dieldrin methoxychlor, methoxychlor epoxide.

**QA indicates number of samples for field QA/QC.

***Water samples include one sample per well (two wells total).

ATTACHMENT 2

Required Sample Detection Limits

Compound	Concentration Water	Soil
Total Organic Halogen (TOX)	5 ug/l	1 ug/g
Oils and Greases (Method 413.2)	0.3 mg/l	300 ug/g
Lead	20 ug/l	0.2 ug/g
Silver	10 ug/l	0.1 ug/g
Mercury	1 ug/l	0.01 ug/g
Sodium	1 mg/l	1 mg/g
Iron	100 ug/l	100 ug/g
Pesticides*	0.02 ug/l	0.02 ug/g
Total Organic Carbon (TOC)	1 mg/l	---
Nitrates	0.1 mg/l	---

*See Attachment 1 for complete listing

Appendix C

Biographies of Key Personnel

Clay N. Culver Position: Geologist

Education:

B.S., 1976, Geology, New Mexico Institute of Mining and Technology, Socorro, N.M.

Short Course, 1980, Remote Sensing for Minerals and Mineral Fuels, South Dakota School of Mines, Rapid City, S.D.

Experience:

HAZARDOUS WASTE/ENVIRONMENTAL MONITORING

Project geologist for Kirtland AFB Installation Restoration Program (IRP) Phase IIB investigations. Duties included supervision of all exploratory drilling, monitor well completions, soil sampling, water sampling and records management. Project is still in an active status pending completion of monitoring, analysis and draft final report preparation for USAF/OEHL at Brooks AFB, San Antonio, TX. Contract period: 1983 to present.

Supervision of drilling, completion, sampling and data management of numerous monitoring and injection/withdrawal wells for uranium mill tailings ground water contamination investigation at United Nuclear Corp.'s Churchrock uranium mill. contract period: 1978-1981.

Ground water and surface water quality sampling and data management for various coal and uranium mine operator's hydrologic monitoring programs in New Mexico, Arizona, Colorado and Utah. Clients have included: Gulf Mineral Resources, Utah International Inc., Northwest Carbon Coal Co., Bokum Resources Corp., Conoco Minerals, Arizona Public Service Co. and United Nuclear Homestake Partners. Contract period: various 1977 to 1981.

HYDROGEOLOGY

Field testing instrumentation technician and staff hydrologist for low permeability testing of the Pasco River Basalts at Rockwell International's Hanford Operations, Hanford, Washington. Contract period: 1979 to 1980.

Field unit for ERDA/NURE Hydrogeochemical and Stream Sediment Reconnaissance Program in the Great Smokey Mountains National Forest. Duties included sample site location, verification, sample site records maintenance and development of field sampling procedures. Contract period: 1976.

Hydrologic and computer modeling assistant for development and applications of coupled finite-element unsaturated and saturated ground water transport model for applications to a nuclear waste storage facility in West Valley, N.Y Contract period: 1983.

MINERAL RESOURCE EVALUATION

Conducted radon gas survey in West-Central New Mexico for shallow uranium reserve exploration. Client confidential. Contract period: 1978.

Lithologic core analysis for leach compatibility study and preliminary geologic/ore reserve cross section maps for New Cinch Uranium Co. near Cuba, N.M.

Preliminary analysis of recovered tar sands cores, hydrologic testinq and preparation of report for Solvex Corp.'s Santa Rosa Tar Sands Project. Report prepared with Glorieta Geoscience under contract to Solvex to indicate concerns with regard to ore grade and area hydrogeology.

Field Assistant to the US Geological Survey in the mapping and geochemical sampling of several study areas in southeast New Mexico and southwest Arizona and Central Monatana.

Stuart E. Faith Position: Consultant

Education:

B.S., 1972, Environmental Engineering, New Mexico Institute of Mining and Technology, Socorro, N.M.
M.S. , 1974, Geochemistry, New Mexico Institute of Mining and Technology, Socorro, N.M.
Short Course, 1978, Management of Rivers and Watersheds, Colorado State University, Ft. Collins. Colo.

Registration:

New Mexico Professional Engineer No. 6396

Qualifications and Experience:

LICENSING AND PERMITTING

Radioactive Materials License applications with supporting environmental and geotechnical data acquisition and management for Bokum Resources Corporation's Marquez, NM uranium mill and tailings disposal facility. RML document prepared under the requirements of the State of New Mexico Radiation Protection Regulations. Contract period: 1976 to present.

Ground Water Discharge Plan preparation for United Nuclear Corporations' Churchrock uranium mill tailings facility under statutory requirements of the New Mexico Water Quality Control Commission Regulations for protection of New Mexico ground waters. Concurrently, flood evaluation and channel stability study for review by the New Mexico State Engineer with regard to approval of potential future use of tailings impoundment embankment (dam), which had previously failed due to foundation settlement. Contract period: 1980 to 1982.

National Pollution Discharge Elimination System (NPDES) permit assistance to Utah International, Inc.'s Navajo Coal Mine and ancillary coal washing facility to Arizona Public Service Co.'s Four Corners Power Plant. Contract period: 1975 to 1977.

Preparation of a Ground Water Discharge Plan for Phelps Dodge Corp.'s Tyrone copper tailing ponds and sewerage treatement facilities. Contract period: 1975 to 1976.

Consultant to the New Mexico Environmental Evaluation Group for evaluation of geotechnical and geochemical data related to the Waste Isolation Pilot Plant near Carlsbad, N.M. Contract period: 1982 to 1983.

ENVIRONMENTAL AND HAZARDOUS WASTE MONITORING

Design, implementation and management of a ground water and vadose (unsaturated) zone monitoring network of wells (2) and pressure/vacuum lysimeters (7) for Kirtland AFB Installation Restoration program (IRP) Phase IIB. Program is in and active status prior to completion of draft final report for AF/OEHL at Brooks AFB in San Antonio, TX.

Geotechnical and hydrological evaluation of ground water contamination at the United Nuclear Homestake Partnership uranium mill near Milan, N.M. Project evolved from initial monitoring network (shallow alluvial monitor wells) for delineation of aerial and vertical extent of contaminant plume. This effort was subsequently followed by the design and installation of interceptor well (barrier) array and fresh water injection well array to contain and flush critical areas of the contaminated aquifer unit. UNHP is currently involved in litigation to determine the extent of liability for contamination of private domestic ground water wells in the area. Contract period: 1975 to 1977.

Statistical evaluation of ground water quality data to delineate contaminated from noncontaminated areas in an aquifer which had previously not been evaluated sufficiently for background concentrations of various inorganic and radiometric analtes. Work performed for United Nuclear Corp.'s Churchrock uranium mill at Chruchrock, N.M. Analysis of these data were included in the Ground Water Discharge Plan prepared for UNC and submitted to the New Mexico EID. Contract period: 1979 to 1981.

GEOTECHNICAL DESIGN

Optimization of chemical flocculent and coagulent feed rates for removal of suspended solids from United Nuclear Corp.'s Churchrock uranium mine dewatering ponds to meet NPDES Effluent Limitations. Treated mine water discharge was later utilized for mill feedwater makeup after the mill was constructed at the same facility. Contract period: 1975.

Design of coal fine waste water treatment facility for Utah International, Inc.'s Navajo Coal Mine. Contract period: 1977.

Assistant project engineer for design of surface water diversion and uranium mill tailings secondary catchment dam for Bokum Resources approved subgade uranium tailings disposal facility at Marquez, N.M. Contract period: 1978 to 1979.

Preliminary evaluation and design of diversion and sediment pond facilities for Utah International Inc.'s Navajo Coal Mine to meet New Mexico Energy and Minerals requiremnts for surface caol mine facilities. Regulations formerly under the adminsitration of the US Dept. of Interior-office of Surface Mining. Contract period: 1980 to 1981.

Design of containment system (berms, vehicular access, emergency drainage) for fuel oil storage facilities owned and operated by various mine operators in New Mexico to meet the requirements of the Spill Prevention, Control and Contingency (SPCC) regulations. Contract periods: various 1976 to 1979.

APPENDIX D

Regional Hydrologic and Geochemical Data

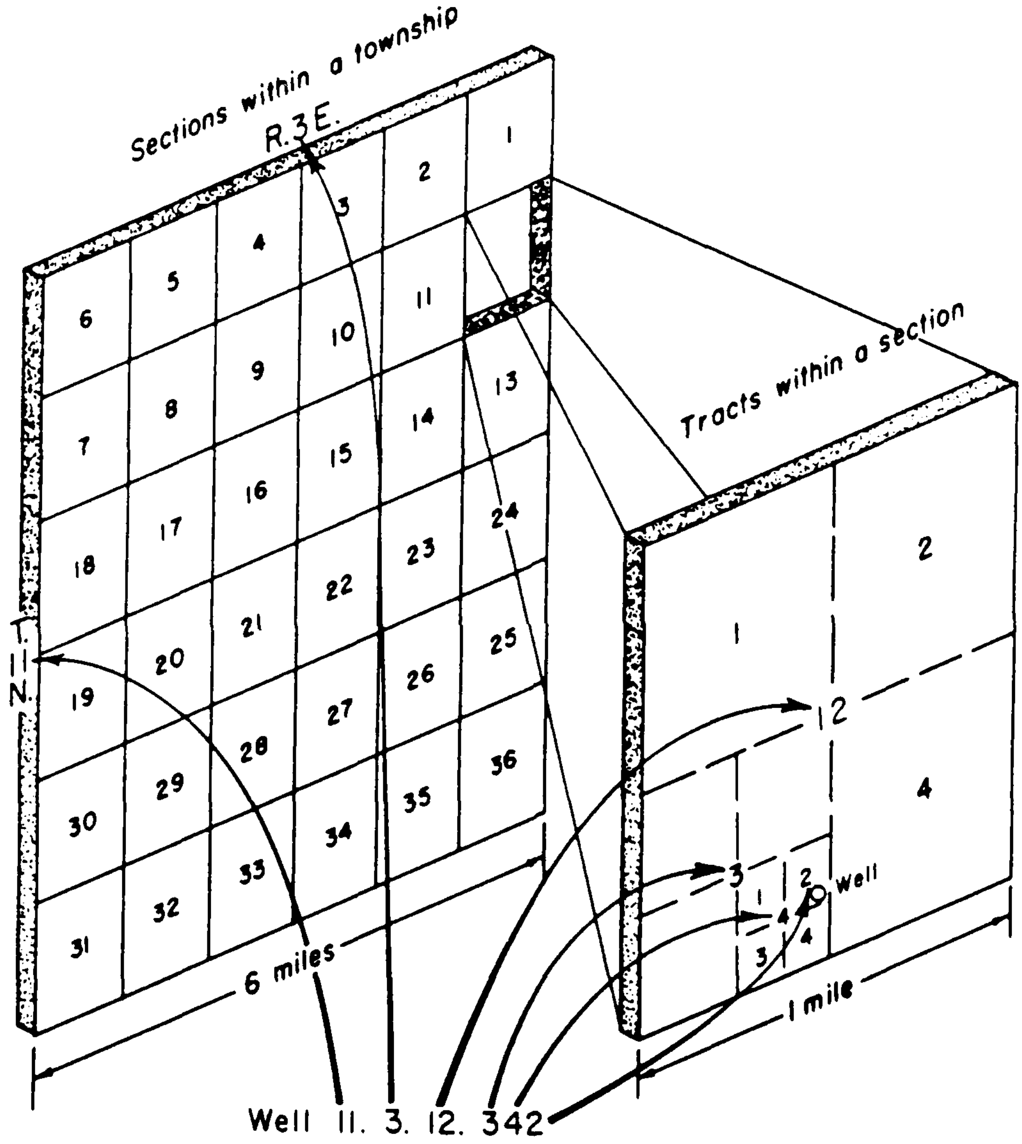


Figure D-1 SYSTEM OF NUMBERING WELLS IN NEW MEXICO
From: COE, 1979

Table D.1 Water Level Data for Municipal/Other Wells

WELL NAME	LOCATION	GROUND ELEVATION (FT, MSL)	DEPTH TO WATER (FT. BGS)	W.L. ELEVATION (FT. MSL)(1)	MEASUREMENT DATE	COMMENTS
Yale #1	T.10N.R.3E.21-443	5160	269.88	4890	7/18/83	-
Yale #3	T.10N.R.3E.28-243	5127	242.10	4885	7/19/83	-
Yale #4	T.10N.R.3E.21-341	5080	188.70	4891	7/19/83	-
San Jose #1	T.10N.R.3E.32-213	4950	39.38	4911	7/18/83	-
San Jose #3	T.10N.R.3E.32-412	4954	54.93	4899	7/21/83	-
San Jose #4	T.10N.R.3E.29-442	4992	101.77	4890	7/18/83	-
San Jose #5	T.10N.R.3E.29-342	4946	48.41	4898	7/19/83	-
San Jose #6	T.10N.R.3E.32-414	4941	38.58	4902	7/19/83	-
San Jose #9	T.10N.R.3E.32-314	4940	31.75	4908	7/19/83	-
Burton #1	T.10N.R.3E.27-244	5324	432.87	4891	7/19/83	-
Burton #3	T.10N.R.3E.23-314	5214	327.88	4886	7/19/83	-
Public Service Co.	T.9N.R.3E.9-234	5107	212.76	4894	8/10/83	-
Insulbead	T.9N.R.3E.5-222	4973	57.37	4916	7/20/83	-
Amerigas	T.9N.R.3E.9-111	5001	102.04	4899	7/20/83	-
State Police Farm #3	T.9N.R.3E.11-333	5142	235.60	4906	7/28/83	-
McCormick Ranch	T.9N.R.3E.36-212	5277	>350	<4927	5/19/82	Parker (1982)
US Veteran's Admin. Hosp.	T.10N.R-3E.36-132	5343	449.65	4891	5/8/84	Measured by SAI with electric sounder. Well idle for approx. 2 mos.
NMEH Yale #1	T.10N.R.3E.34-322	5302	406.45	4896	7/20/83	-
NMEH Yale #2	T.10N.R.3E.33-413	5164	250.39	4914	7/27/83	-

1) Data from Kues (1983, personal communication) - USGS provisional records - subject to revision unless otherwise noted. All water levels rounded to nearest whole foot by SAI.

Table D.2 Water Level Data for KAFB Wells

WELL NAME	LOCATION	GROUND ELEVATION (FT, MSL)	DEPTH TO WATER (FT. BGS)	W.L. ELEVATION (FT. MSL)(1)	MEASUREMENT DATE	COMMENTS
Kirtland AFB #1	T.10N.R.4E.31-411	5383.4	502	4882	7/24/83	-
Kirtland AFB #2	T.9N.R.3E.1-112	5318.2	425	4894	7/24/83	-
Kirtland AFB #3	T.10N.R.4E.30-321	5353.7	469	4886	7/19/83	-
Kirtland AFB #4	T.9N.R.4E.6-322	5361.6	469	4894	7/24/83	-
Kirtland AFB #5	T.10N.R.4E.29-324	5433.7	548	4887(E)	6/7/82	Project WL from 1982 records. No permanent measuring system.
Kirtland AFB #6	T.10N.R.4E.32-433	5420.8	588	4884(E)	7/24/83	Pumping constantly. WL is estimated. No records 1/81 to 5/83.
Kirtland AFB #7	T.9N.R.3E.1-222	5349.0	463	4887.	7/23/83	Estimate static WL at 4888.
Kirtland AFB #8	T.9N.R.4E.5-333	5378.5	483	4897	7/19/83	-
Kirtland AFB #9	T.9N.R.4E.15-311	5501.4	-	4950(E)	10/49	Abandoned - well reported welded shut.
Kirtland AFB #10	T.9N.R.4E.20-221	5425.0	479	4947(E)	1978(2)	DOE owned for emergency use only. Last measured in 1978. No permanent measuring equipment.
Kirtland AFB #11	T.9N.R.4E.4-211	5468.0 $\pm$	580	4889	7/?/83	Measured by KAFB personnel with steel tape. No permanent measuring equipment.
Kirtland AFB #12	T.10N.R.3E.36-111	5320.2 $\pm$	-	4890(E)	-	WxLx is estimated. No permanent measuring equipment.
Kirtland AFB #13	T.10N.R.4E.34-144	5303.0	415	4889	7/18/83	Used NMEH Yale #1 (4896 ft, MSL) for this location.
Kirtland AFB #14	T.10N.R.3E.35-322	5322. $\pm$	436	4888	7/23/83	-
Bldg. 29055 Well	T.9N.R.4E.35-144	5713. $\pm$	54	5659	N/A	Reported by ESI, 1981 p. 3-17.
DM-01	T.9N.R.3E.1-111	5318.4	420.7	4898	2/10/84	By SAI personnel with electric sounder.
DM-02	T.9N.R.4E.7-222	5282.4	378.5	4904	2/10/84	By SAI personnel with electric sounder.

1) WL elev. determined by bubble manometer recorded on 1-week circular chart and rounded to nearest whole foot unless otherwise noted. Manometer installed and operated by KAFB personnel unless otherwise noted.

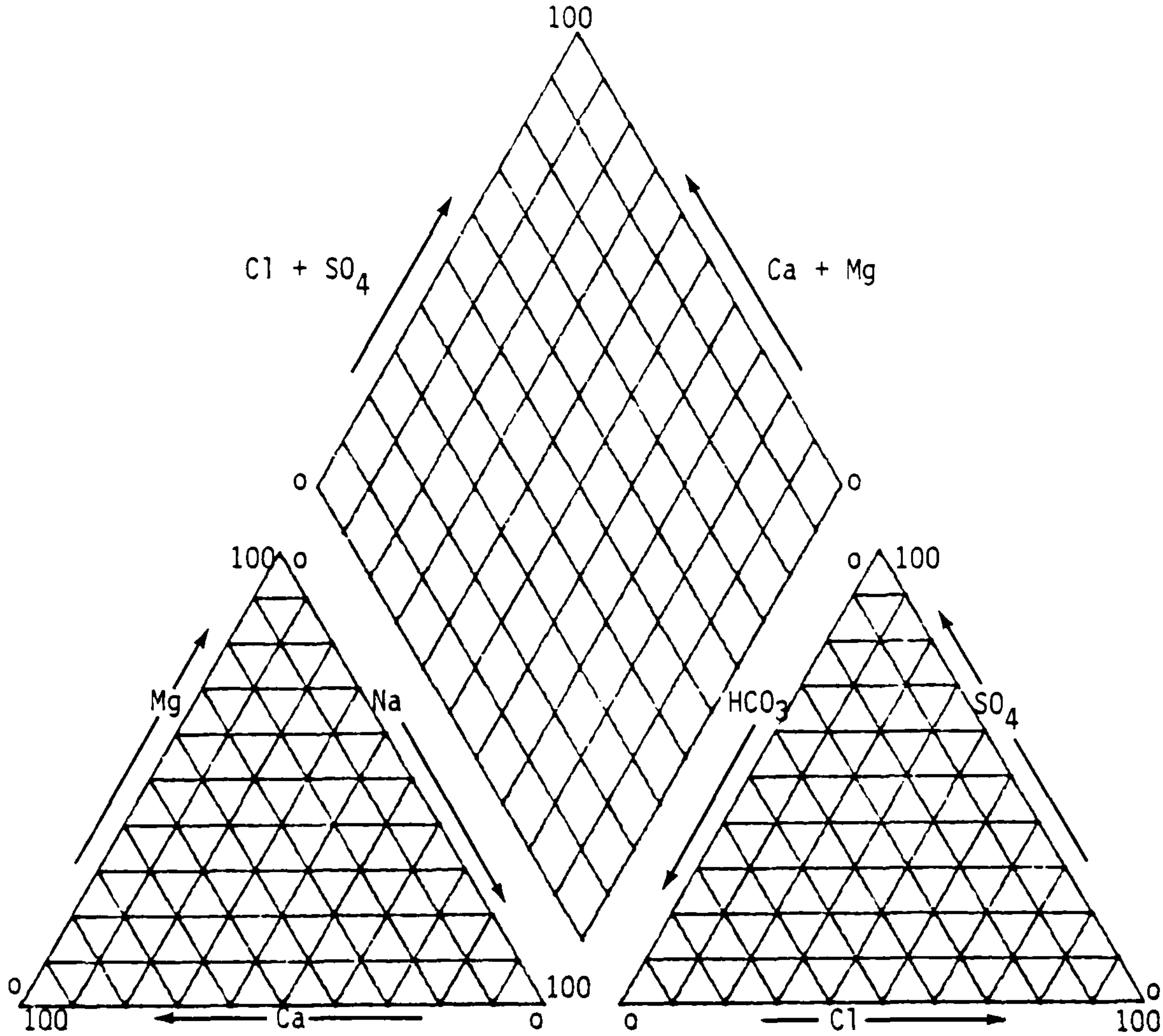
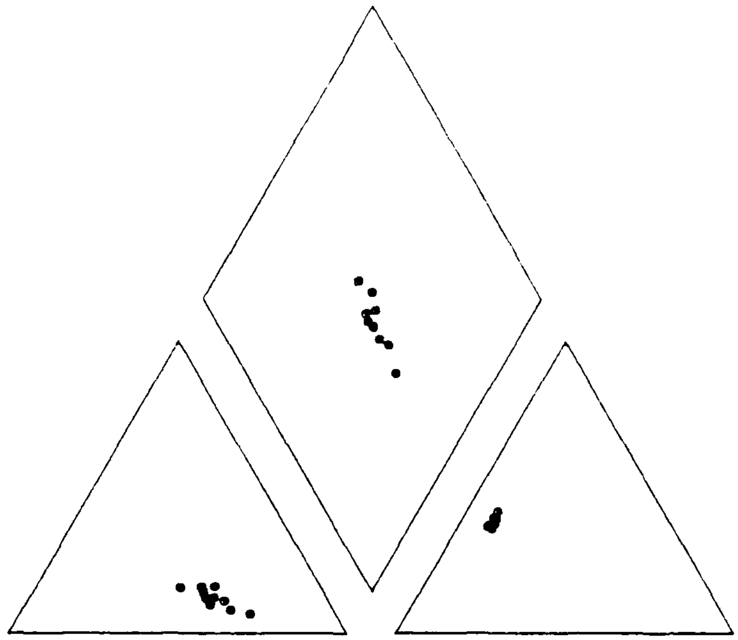
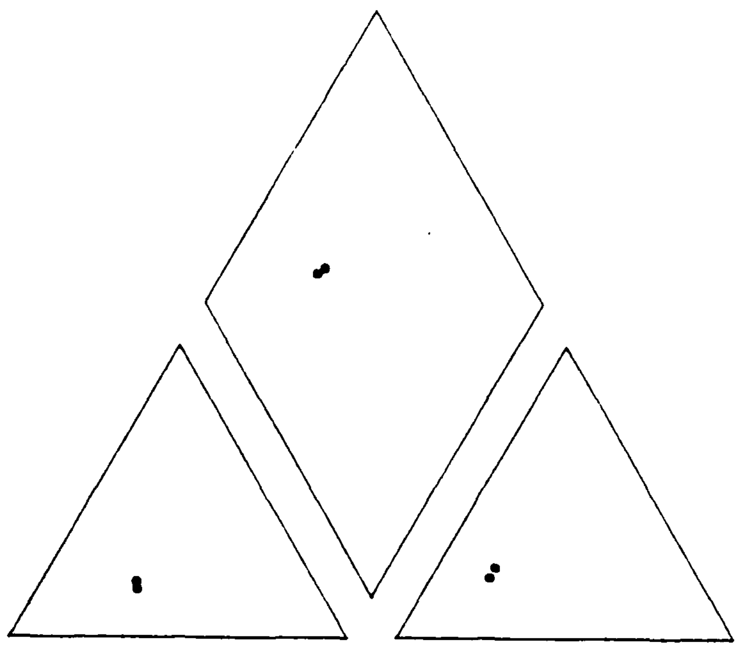


Figure D-2. Piper Plot-Reference Diagram

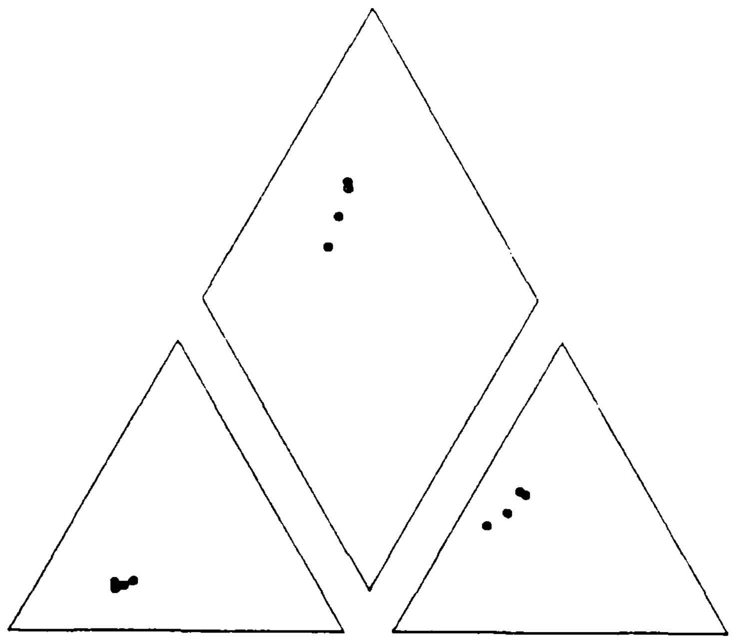


ATRISCO WELL FIELD

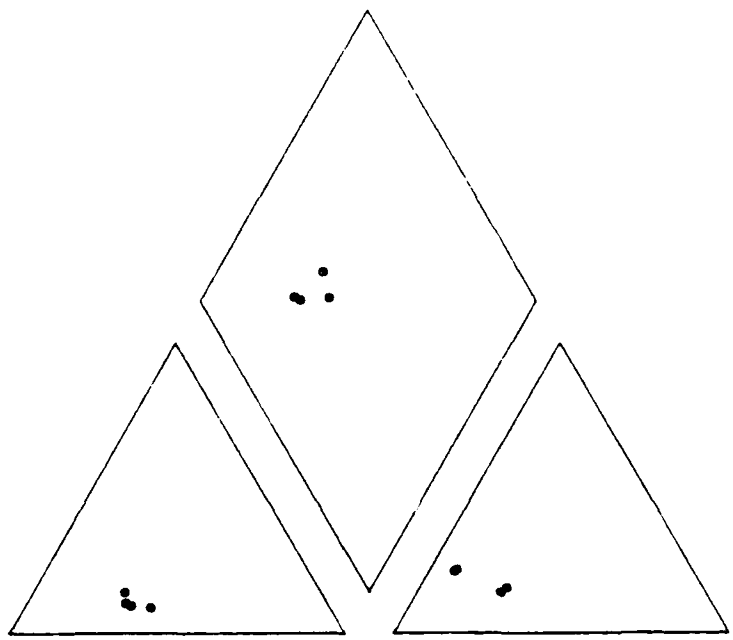


BURTON WELL FIELD

Figure D-3

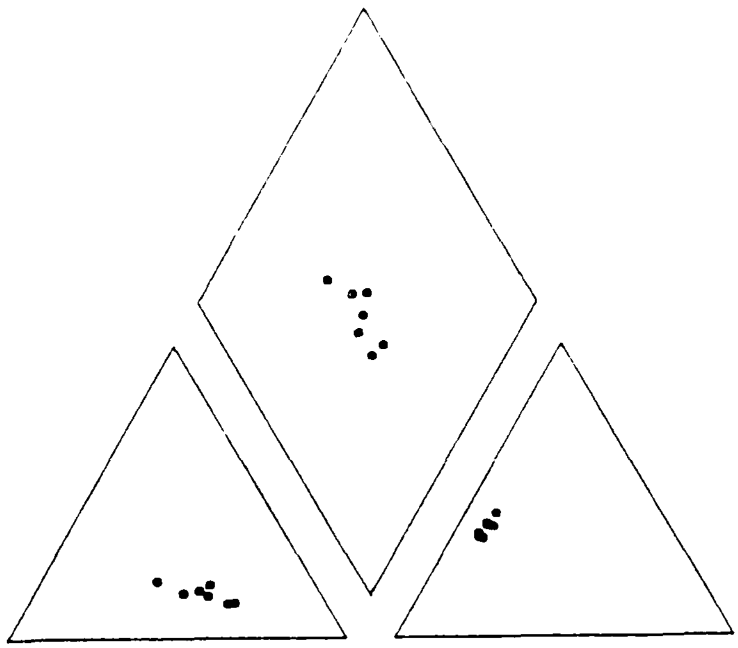


CANDELARIA WELL FIELD

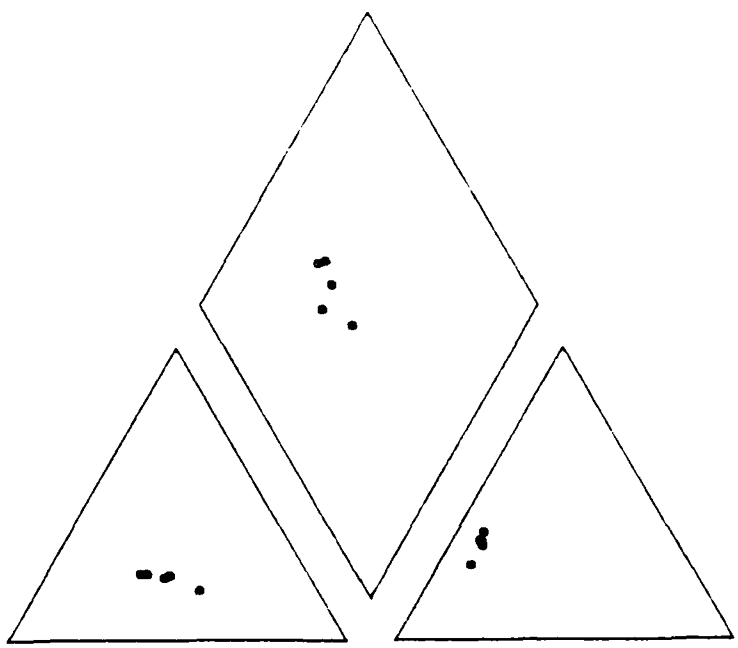


CHARLES WELL FIELD

Figure D-4

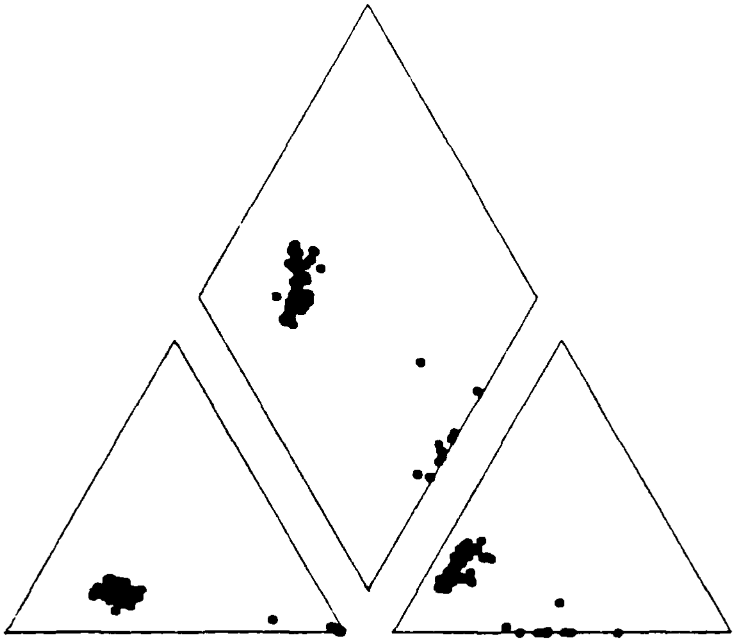


DURANES WELL FIELD

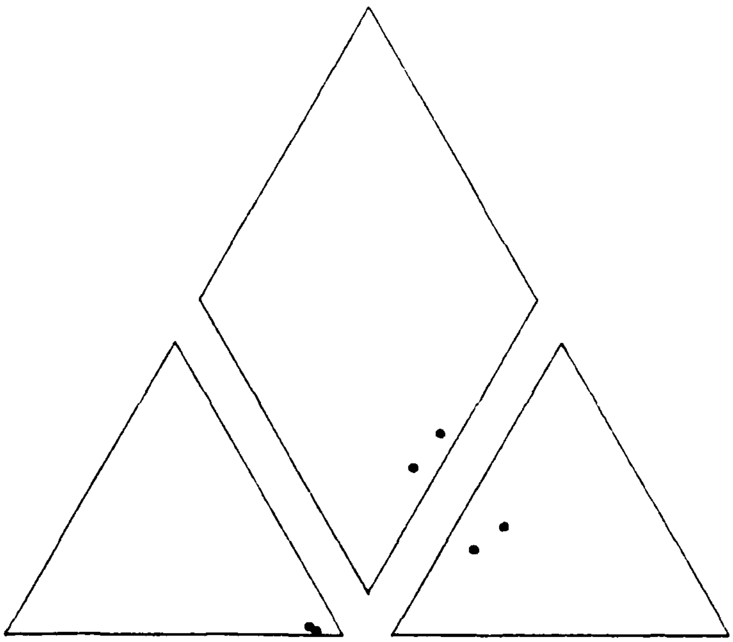


GRIEGOS WELL FIELD

Figure D-5

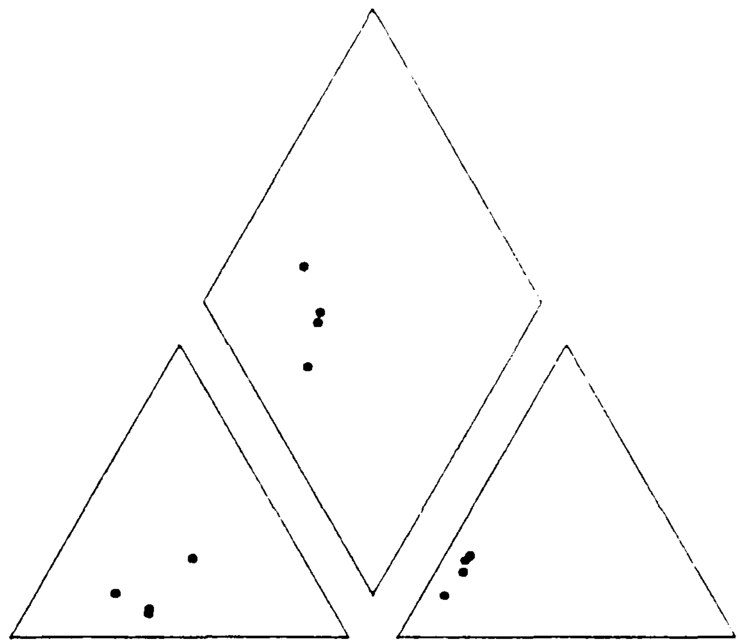


KAFB PRODUCTION WELLS

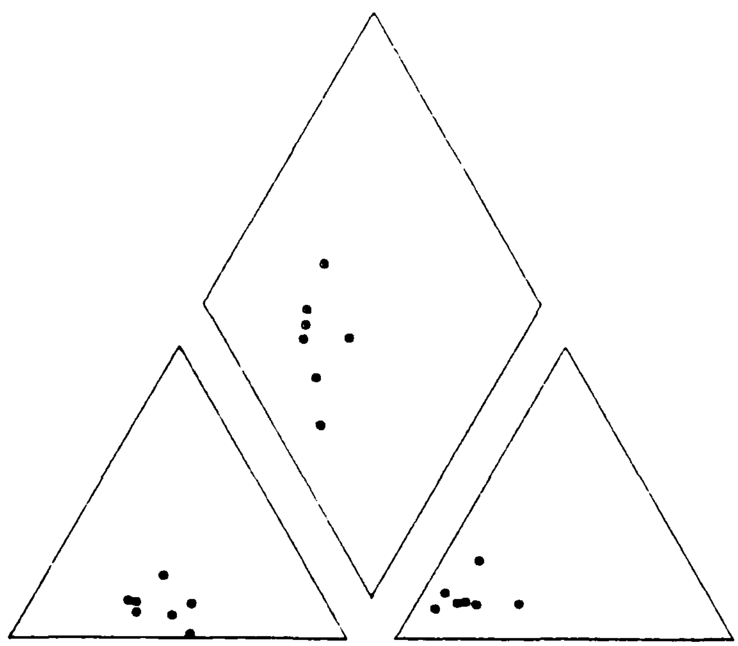


LEAVITT WELL FIELD

Figure D-6

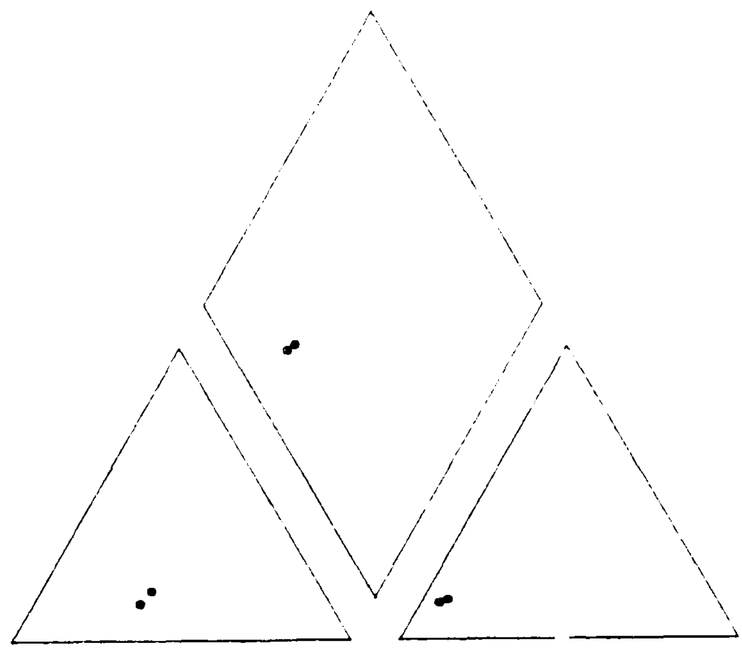


LØMAS WELL FIELD

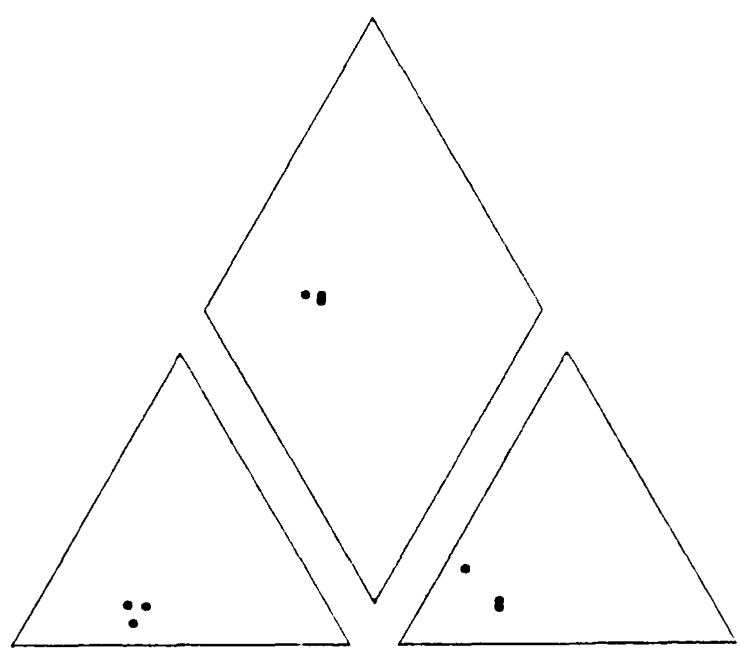


LØVE WELL FIELD

Figure D-7

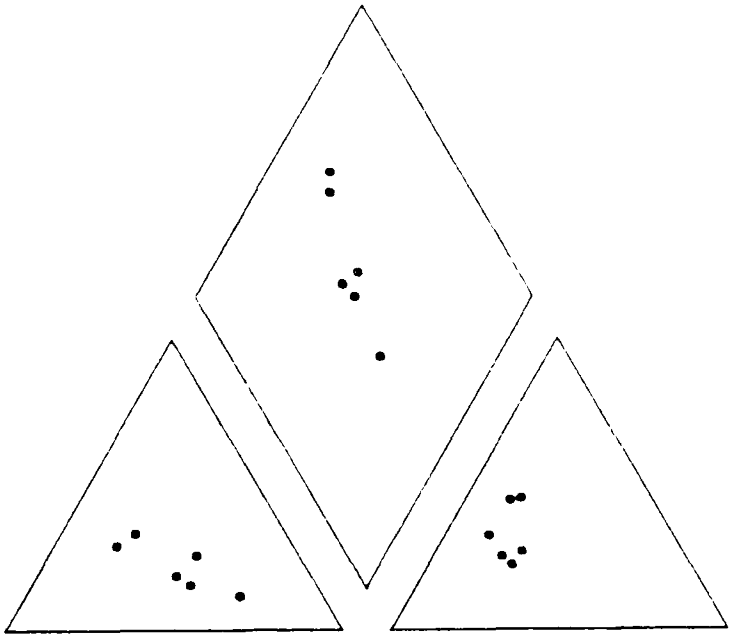


PONDEROSA WELL FIELD

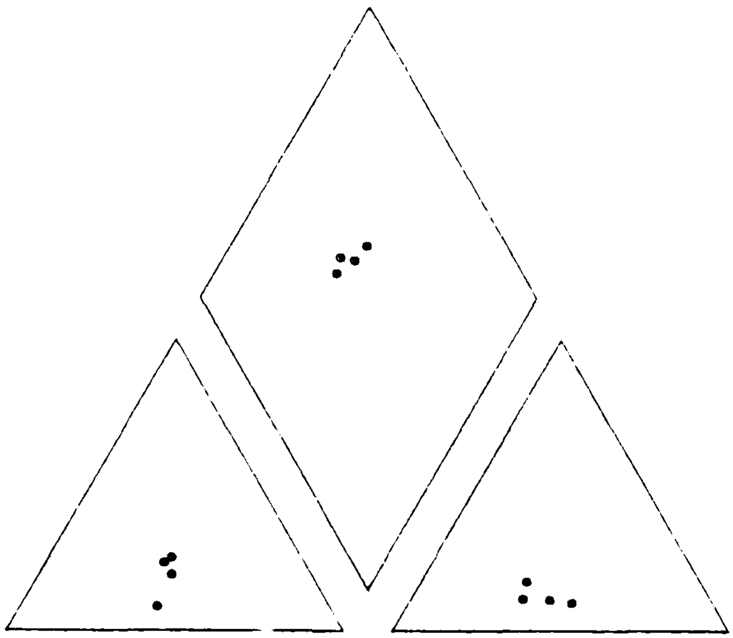


RIDGECREST WELL FIELD

Figure D-8

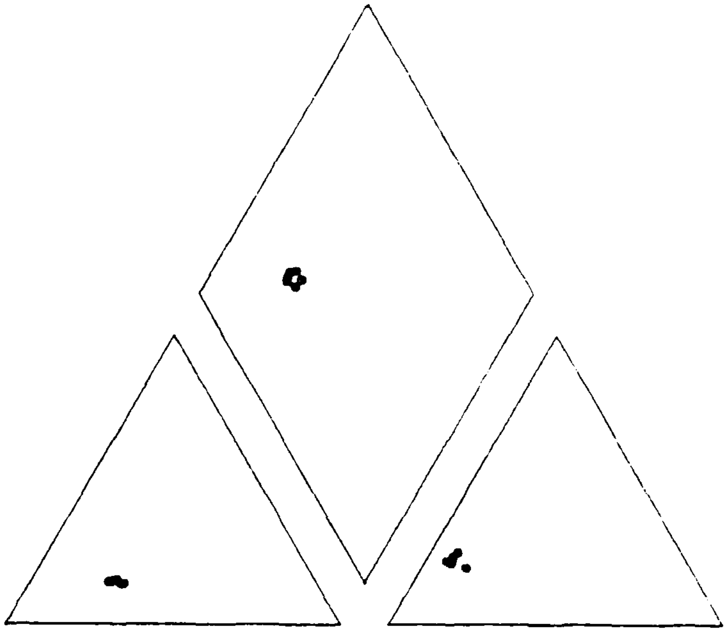


SAN JOSE WELL FIELD

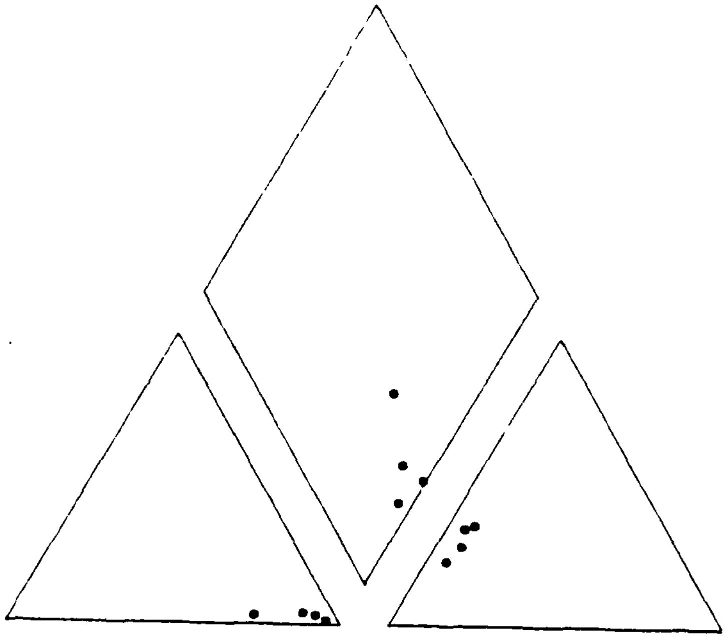


THOMAS WELL FIELD

Figure D-9

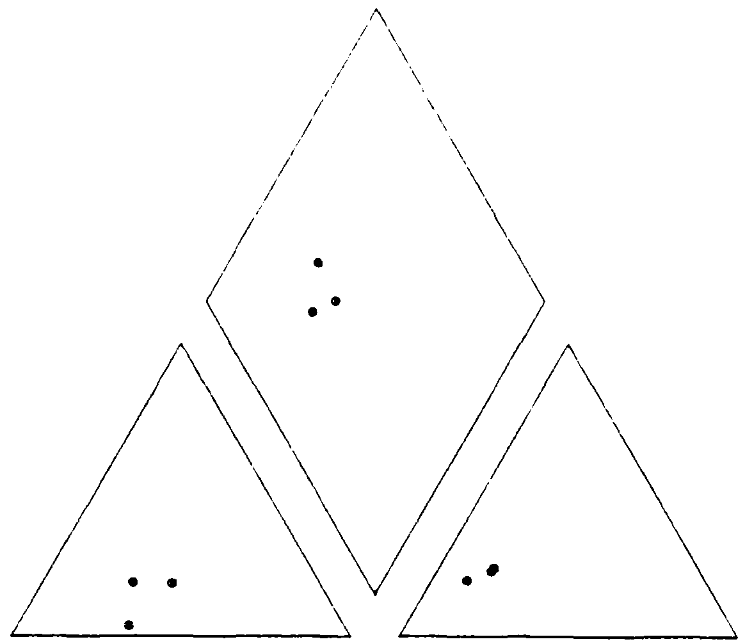


VOL ANDIA WELL FIELD

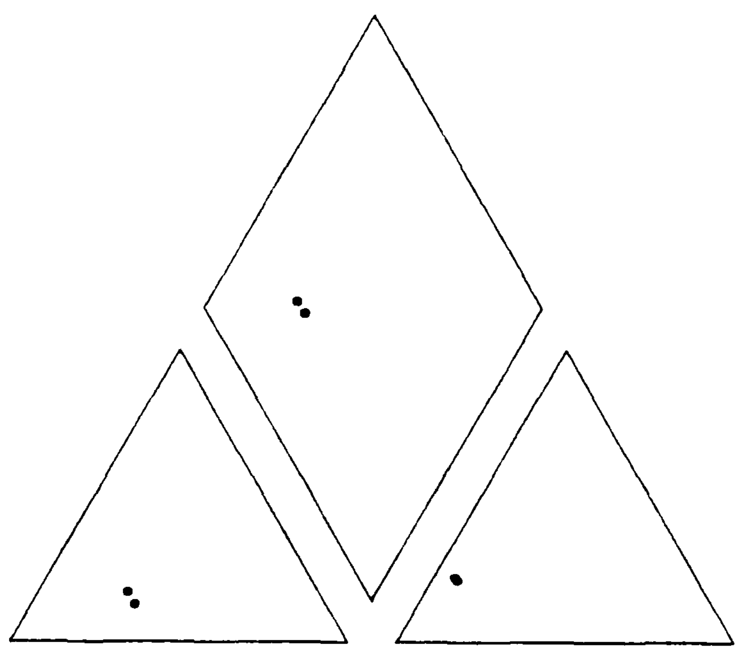


WEST MESA WELL FIELD

Figure D-10



YALE WELL FIELD



MONTESSA PK. & POLICE FARM WELLS

Figure D-11

Table D-3 Kirtland AFB Geochemical Data

WELL NO 1-F

		May 1959	May 1960	May 1961	May 1962	1963	1964	1965	1966	Nov 1967	Nov 1968	Sept 1968	1970	Sept 1971	Oct 1972	1973	Dec 1974	Nov 1975	1976	1977	1978
Silica	mg/l	23.	28.	26.	27.					12.	10.	26.		29.			23.	25.			
Iron	mg/l	0.28	0.06	0.08	0.15					0.05	0.36	0.06		0.01			0.49	1.1			
Manganese	mg/l	0.00	0.00	0.00	0.00					0.00	0.00	0.00		0.00			0.01	0.01			
Color		1.	0.	1.	0.					5.	15.	3.		0.			0.	1.			
pH		7.7	7.5	7.6	7.8					7.9	8.0	7.5		7.7			7.9	8.0			
Specific																					
Conductance	umhos/cm	389.	504.	395.	395.					1410.	1490.	430.		428.			444.	450.			
Dissolved Solids																					
Residue at 180	mg/l	249.	333.	253.	252.					810.	846.	280.		274.			285.	269.			
Calculated (sum)	mg/l	261.	324.	254.	257.					792.	838.	274.		277.			280.	275.			
Hardness as CaCO3																					
Total	mg/l	146.	207.	148.	150.					15.	14.	162.		150.			170.	160.			
Noncarbonate	mg/l	5.	28.	6.	8.					0.	0.	20.		9.			30.	21.			
Alkalinity-CaCO3	mg/l	141.	169.	142.	143.					387.	404.	143.		144.			139.	139.			
CO2 (calc)	mg/l	5.5	10.	6.9	4.4					9.0	8.0	8.7		5.6			3.4	2.7			
SAR		1.1												1.0			0.9	0.9			
Langlier																					
Index at 25														-0.1			+0.2	+0.3			
Cations																					
Calcium	mg/l	50.	68.	51.	53.					3.2	4.6	53.		49.			55.	52.			
Magnesium	mg/l	5.1	9.1	5.1	4.4					1.7	0.6	7.3		7.6			7.6	7.3			
Sodium	mg/l	30.	28.	27.	27.					310.	335.	29.		28.			27.	26.			
Potassium	mg/l									1.5	1.4			2.7			3.2	2.9			
Anions																					
Bicarbonate	mg/l	172.	206.	173.	174.					472.	493.	174.		176.			169.	159.			
Carbonate	mg/l	0.	0.	0.	0.					0.	0.	0.		0.			0.	0.			
Sulfate	mg/l	49.	75.	48.	48.					0.6	0.2	55.		56.			59.	62.			
Chloride	mg/l	12.	12.	9.0	9.1					229.	241.	15.		14.			14.	13.			
Fluoride	mg/l	0.5	0.5	0.5	0.5					0.7	0.8	0.6		0.5			0.5	0.5			
Nitrate+Nitrite	mg/l	1.7	2.4	2.0	2.1					0.2	1.9	2.0		0.77			0.02	[illegible]			

Source: KAFB/CES (1983)

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 2-F

		May 1959	May 1960	May 1961	May 1962	Jun 1963	1964	1965	1966	Jul 1967	1968	1969	1970	Sept 1971	Oct 1972	1973	1974	1975	1976	1977	1978
Silica	mg/l	34.	33.	32.	33.	34.				35.				36.	35.						
Iron	mg/l	0.00	0.06	0.01	0.03	0.02				0.00				0.01	0.02						
Manganese	mg/l	0.00	0.00	0.00	0.00	0.00				0.00				0.00	0.00						
Color		1.	0.	0.	0.	1.				0.				0.	2.						
pH		7.8	7.4	7.7	7.7	7.4				7.8				7.6	6.8						
Specific																					
Conductance	umhos/cm	297.	299.	320.	317.	316.				321.				321.	308.						
Dissolved Solids																					
Residue at 180	mg/l	200.	204.	211.	208.	214.				212.				212.	236.						
Calculated (sum)	mg/l	207.	199.	209.	209.	213.				207.				216.	208.						
Hardness as CaCO3																					
Total	mg/l	108.	105.	110.	111.	112.				109.				110.	110.						
Noncarbonate	mg/l	0.	0.	0.	0.	0.				1.				0.	0.						
Alkalinity-CaCO3	mg/l	112.	110.	111.	111.	112.				108.				111.	112.						
CO2 (calc)	mg/l	3.4	8.4	4.3	4.3	8.6				3.3				5.4	34.						
SAR		1.0												1.0	1.0						
Langlier																					
Index at 25														-0.4	-1.2						
Cations																					
Calcium	mg/l	35.	34.	36.	37.	35.				36.				34.	34.						
Magnesium	mg/l	5.0	4.9	4.9	4.5	6.0				4.6				5.3	5.1						
Sodium	mg/l	24.	23.	25.	24.	25.				23.				23.	23.						
Potassium	mg/l													2.3	[illegible]						
Anions																					
Bicarbonate	mg/l	136.	134.	135.	135.	136.				132.				135.	136.						
Carbonate	mg/l	0.	0.	0.	0.	0.				0.				0.	0.						
Sulfate	mg/l	29.	29.	27.	28.	28.				23.				33.	29.						
Chloride	mg/l	12.	9.0	17.	16.	17.				15.				15.	13.						
Fluoride	mg/l	0.6	0.5	0.4	0.4	0.4				0.3				0.5	0.5						
Nitrate+Nitrite	mg/l	0.1	0.0	0.3	0.3	0.3				0.3				0.12							

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 3-[illegible]

		May 1959	May 1960	May 1961	May 1962	Jun 1963	1964	1965	Jul 1967	Nov 1967	Nov 1968	1969	1970	Sept 1971	Oct 1972	1973	1974	1975	1976	1977	1978
Silica	mg/l	26.	26.	25.	26.	26.			31.	13.	11.			28.	27.						
Iron	mg/l	0.52	0.03	0.00	0.01	0.06			0.00	0.04	0.04			0.00	0.01						
Manganese	mg/l	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00			0.01	0.00						
Color		1.	1.	0.	0.	1.			0.	5.	20.			0.	1.						
pH		7.9	7.6	7.6	7.8	7.8			7.6	8.0	7.9			7.7	6.8						
Specific																					
Conductance	umhos/cm	304.	308.	309.	306.	307.			315.	1670.	1650.			316.	305.						
Dissolved Solids																					
Residue at 180	mg/l	190.	206.	195.	192.	200.			204.	960.	950.			200.	208.						
Calculated (sum)	mg/l	200.	194.	198.	198.	198.			204.	951.	946.			205.	202.						
Hardness as CaCO3																					
Total	mg/l	110.	113.	114.	115.	114.			112.	10.	10.			110.	110.						
Noncarbonate	mg/l	0.	0.	0.	0.	0.			0.	0.	0.			0.	0.						
Alkalinity-CaCO3	mg/l	123.	122.	125.	125.	124.			121.	394.	410.			126.	121.						
CO2 (calc)	mg/l	3.0	6.0	6.1	3.8	3.8			5.9	8.0	10.0			4.9	38.						
SAR		1.0												0.9	0.9						
Langlier																					
Index at 25														-0.2	-1.0						
Cations																					
Calcium	mg/l	39.	38.	39.	41.	38.			38.	2.0	3.2			37.	37.						
Magnesium	mg/l	3.6	4.4	4.0	3.0	4.6			4.1	1.2	0.5			4.9	4.7						
Sodium	mg/l	24.	21.	22.	21.	22.			23.	384.	300.			21.	22.						
Potassium	mg/l									1.1	1.3			2.5	2.3						
Anions																					
Bicarbonate	mg/l	150.	149.	152.	153.	151.			148.	480.	500.			153.	148.						
Carbonate	mg/l	0.	0.	0.	0.	0.			0.	0.	0.			0.	0.						
Sulfate	mg/l	23.	23.	24.	23.	24.			24.	0.6	2.2			25.	24.						
Chloride	mg/l	9.5	6.6	6.5	7.1	7.4			8.7	312.	300.			9.3	9.5						
Fluoride	mg/l	0.4	0.4	0.5	0.4	0.5			0.3	1.0	1.0			0.5	0.6						
Nitrate+Nitrite	mg/l	1.5	1.6	1.8	1.4	1.9			1.9	0.5	0.5			0.5							

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 4-[illegible]

		1959	May 1960	May 1961	May 1962	Jun 1963	1964	1965	Jul 1966	Nov 1967	Nov 1968	Sept 1968	1970	Sept 1971	Oct 1972	1973	Dec 1974	1975	1976	1977	1978
Silica	mg/l		28.	26.	27.	27.			27.	12.	10.	26.		29.	28.		29.				
Iron	mg/l		0.05	0.03	0.01	0.02			0.01	0.02	1.1	0.07		0.01	0.02		0.00				
Manganese	mg/l		0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		0.00	0.00		0.00				
Color			0.	0.	0.	0.			5.	10.	20.	3.		3.	3.		0.				
pH			7.5	7.4	7.7	7.6			7.5	7.9	7.2	7.7		7.7	7.0		8.4				
Specific																					
Conductance	umhos/cm		449.	521.	450.	444.			452.	1020.	369.	432.		447.	341.		434.				
Dissolved Solids																					
Residue at 180	mg/l		290.	338.	290.	295.			302.	630.	206.	280.		284.	224.		274.				
Calculated (sum)	mg/l		288.	332.	289.	287.			287.	610.	206.	277.		287.	226.		272.				
Hardness as CaCO3																					
Total	mg/l		178.	215.	179.	176.			174.	6.	40.	170.		170.	120.		160.				
Noncarbonate	mg/l		26.	46.	24.	24.			20.	0.	0.	14.		14.	0.		9.				
Alkalinity-CaCO3	mg/l		153.	170.	155.	152.			154.	303.	79.	156.		153.	130.		152.				
CO2 (calc)	mg/l		9.3	13.	6.0	7.4			9.4	7.0	10.0	5.1		6.0	25.		1.2				
SAR														0.9	1.0		0.9				
Langlier																					
Index at 25														0.0	-0.8		+0.7				
Cations																					
Calcium	mg/l		57.	68.	59.	60.			55.	1.3	13.	54.		52.	39.		50.				
Magnesium	mg/l		8.8	11.	7.8	6.4			9.0	0.7	1.8	8.6		9.0	6.3		8.7				
Sodium	mg/l		27.	28.	27.	27.			29.	239.	60.	28.		26.	25.		25.				
Potassium	mg/l									1.0	1.7			2.8	2.5		3.0				
Anions																					
Bicarbonate	mg/l		186.	207.	189.	185.			188.	370.	96.	190.		187.	159.		185.				
Carbonate	mg/l		0.	0.	0.	0.			0.	0.	0.	0.		0.	0.		0.				
Sulfate	mg/l		62.	79.	61.	60.			60.	0.2	17.	55.		61.	36.		50.				
Chloride	mg/l		11.	14.	11.	12.			12.	173.	54.	9.6		11.	7.7		11.				
Fluoride	mg/l		0.6	0.5	0.5	0.7			0.6	0.4	0.7	0.7		0.5	0.7		0.6				
Nitrate+Nitrite	mg/l		2.7	3.2	2.9	2.8			2.5	0.1	0.5	2.1		0.87			[illegible]				

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 5-E

		May 1959	1960	May 1961	May 1962	Jun 1963	Jun 1964	1965	Jul 1967	Nov 1967	Nov 1968	Nov 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Silica	mg/l	26.		25.	26.	26.	26.		26.	12.	7.4	27.									
Iron	mg/l	0.03		0.00	0.05	0.02	0.03		0.01	0.06	1.3	0.37									
Manganese	mg/l	0.00		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00									
Color		1.		1.	2.	0.	1.		0.	30.	40.	1.									
pH		7.4		7.4	7.7	7.4	7.6		7.5	7.4	7.7	8.1									
Specific Conductance	umhos/cm	556.		542.	491.	455.	447.		448.	1040.	1080.	440.									
Dissolved Solids																					
Residue at 180	mg/l	350.		351.	316.	300.	286.		300.	600.	606.	286.									
Calculated (sum)	mg/l	353.		345.	320.	290.	286.		292.	587.	598.	283.									
Hardness as CaCO3																					
Total	mg/l	232.		223.	197.	177.	172.		170.	6.	5.	174.									
Noncarbonate	mg/l	50.		36.	16.	18.	13.		17.	0.	0.	20.									
Alkalinity-CaCO3	mg/l	182.		187.	180.	159.	159.		153.	300.	302.	154.									
CO2 (calc)	mg/l	14.		14.	7.0	12.0	7.8		9.4	23.0	12.0	2.4									
SAR		0.8																			
Langlier Index at 25																					
Cations																					
Calcium	mg/l	77.		75.	66.	57.	56.		57.	1.2	2.0	54.									
Magnesium	mg/l	9.7		8.8	7.9	8.5	7.9		6.8	0.7	0.00	9.6									
Sodium	mg/l	29.		30.	32.	29.	30.		32.	231.	242.	28.									
Potassium	mg/l									1.1	1.1										
Anions																					
Bicarbonate	mg/l	222.		228.	220.	194.	194.		187.	366.	368.	188.									
Carbonate	mg/l	0.		0.	0.	0.	0.		0.	0.	0.	0.									
Sulfate	mg/l	77.		78.	66.	60.	58.		63.	0.2	0.2	55.									
Chloride	mg/l	19.		11.	10.	10.	9.0		12.	160.	163.	13.									
Fluoride	mg/l	0.9		0.4	0.4	0.7	0.6		0.4	0.4	0.3	0.6									
Nitrate+Nitrite	mg/l	5.6		5.2	3.7	3.5	3.7		3.3	0.4	1.3	3.8									

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 6-1

		May 1959	May 1960	May 1961	May 1962	Jun 1963	1964	1965	1966	Nov 1967	Nov 1968	Nov 1969	1970	Sept 1971	Oct 1972	1973	1974	Nov 1975	1976	1977	1978
Silica	mg/l	25.	25.	24.	25.	25.				12.	9.4	27.		26.	26.			24.			
Iron	mg/l	0.01	0.02	0.10	0.64	0.18				0.05	1.2	0.00		0.16	0.31			0.07			
Manganese	mg/l	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00		0.00	0.00			0.00			
Color		1.	0.	1.	1.	1.				10.	15.	1.		0.	2.			0.			
pH		7.7	7.4	7.4	7.7	7.4				8.0	7.8	7.8		7.5	6.9			7.7			
Specific																					
Conductance	umhos/cm	527.	538.	532.	535.	506.				1120.	1510.	499.		541.	507.			494.			
Dissolved Solids																					
Residue at 180	mg/l	350.	354.	344.	348.	338.				647.	841.	322.		342.	342.			297.			
Calculated (sum)	mg/l	337.	341.	338.	338.	323.				616.	841.	336.		342.	327.			302.			
Hardness as CaCO3																					
Total	mg/l	226.	229.	224.	225.	207.				6.	12.	210.		210.	210.			190.			
Noncarbonate	mg/l	52.	56.	50.	53.	42.				0.	0.	32.		40.	41.			24.			
Alkalinity-CaCO3	mg/l	175.	174.	174.	172.	166.				319.	387.	178.		174.	170.			163.			
CO2 (calc)	mg/l	6.8	13.	13.	6.7	13.0				6.	12.0	5.4		11.	42.			6.4			
SAR		0.7												0.8	0.8			0.6			
Langlier																					
Index at 25														0.0	-0.6			+0.1			
Cations																					
Calcium	mg/l	76.	76.	75.	76.	67.				1.5	3.6	64.		69.	68.			59.			
Magnesium	mg/l	8.8	9.6	9.0	8.6	9.7				0.5	0.7	12.		10.	10.			9.8			
Sodium	mg/l	25.	25.	26.	25.	28.				242.	338.	32.		26.	27.			25.			
Potassium	mg/l									0.9	1.4			2.0	2.1			2.8			
Anions																					
Bicarbonate	mg/l	213.	212.	210.	202.	389.				472.	213.	212.		207.	199.			199.			
Carbonate	mg/l	0.	0.	0.	0.	0.				0.	0.	0.		0.	0.			0.			
Sulfate	mg/l	76.	80.	79.	79.	73.				0.2	0.0	74.		73.	68.			61.			
Chloride	mg/l	14.	13.	12.	13.	14.				166.	253.	11.		14.	13.			12.			
Fluoride	mg/l	0.4	0.3	0.3	0.4	0.6				0.4	0.9	0.4		0.3	0.5			0.6			
Nitrate+Nitrite	mg/l	6.6	8.1	8.7	8.3	6.8				0.2	1.2	8.3		2.90				2.10			

Table D-3 Kirtland AFB Geochemical Data (Continued)

WELL NO. 7-E

		May 1959	May 1960	May 1961	May 1962	Jun 1963	Jun 1964	1965	Jul 1966	Nov 1967	Nov 1968	1969	1970	Sept 1971	Oct 1972	1973	1974	Nov 1975	1976	1977	1978
Silica	mg/l	27.	28.	27.	27.	28.	28.		28.	19.	15.			30.	28.			25.			
Iron	mg/l	0.10	0.15	0.18	0.01	0.03	0.02		0.01	0.06	0.67			0.01	0.06			2.1			
Manganese	mg/l	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00			0.00	0.00			0.03			
Color		1.	0.	0.	0.	0.	2.		0.	5.	20.			0.	2.			0.			
pH		8.0	7.6	7.7	7.9	7.7	7.8		7.7	7.6	7.9			7.7	7.1			7.9			
Specific																					
Conductance	umhos/cm	328.	325.	330.	345.	348.	354.		357.	755.	1260.			355.	313.			318.			
Dissolved Solids																					
Residue at 180	mg/l	210.	212.	210.	222.	228.	238.		244.	444.	710.			228.	202.			221.			
Calculated (sum)	mg/l	217.	210.	214.	223.	225.	231.		232.	443.	710.			233.	205.			200.			
Hardness as CaCO3																					
Total	mg/l	124.	121.	124.	132.	131.	134.		135.	20.	25.			130.	110.			110.			
Noncarbonate	mg/l	0.00	0.	0.	0.00	0.00	0.		2.	0.00	0.00			0.00	0.00			0.			
Alkalinity-CaCO3	mg/l	128.	125.	129.	132.	130.	134.		134.	253.	338.			134.	124.			121.			
CO2 (calc)	mg/l	2.5	6.1	5.0	3.2	5.1	4.1		5.2	12.0	8.0			5.2	19.			3.0			
SAR		0.9												0.8	0.9			0.9			
Langlier																					
Index at 25														-0.1	-0.7			+0.0			
Cations																					
Calcium	mg/l	41.	40.	40.	45.	43.	45.		43.	4.5	5.2			41.	35.			36.			
Magnesium	mg/l	5.2	5.1	5.8	4.7	5.7	5.2		6.7	2.1	2.9			6.1	5.6			5.8			
Sodium	mg/l	24.	22.	23.	23.	24.	24.		25.	167.	276.			22.	22.			21.			
Potassium	mg/l									1.7	1.8			2.2	1.9			2.3			
Anions																					
Bicarbonate	mg/l	156.	152.	157.	161.	159.	164.		163.	308.	412.			163.	151.			147.			
Carbonate	mg/l	0.	0.	0.	0.	0.	0.		0.	0.	0.			0.	0.			0.			
Sulfate	mg/l	29.	29.	31.	34.	35.	37.		37.	7.4	3.2			39.	27.			26.			
Chloride	mg/l	11.	7.8	7.8	7.7	8.4	7.4		9.6	89.	202.			8.6	8.7			8.9			
Fluoride	mg/l	0.5	0.5	0.5	0.4	0.6	0.4		0.4	0.4	0.5			0.5	0.5			0.5			
Nitrate+Nitrite	mg/l	1.9	2.0	2.0	2.1	2.3	2.5		2.2	0.1	0.8			0.75				0.50			

Table D-3 Kirtland AFB Geochemical Data (Concluded)

WELL NO. 8-E

		May 1959	May 1960	May 1961	May 1962	Jun 1963	Jun 1964	1965	Jul 1966	1967	Sept 1968	Nov 1969	1970	Sept 1971	Oct 1972	1973	1974	1975	1976	1977	1978
Silica	mg/l	29.	28.	26.	27.	27.	27.		27.		26.	30.		30.	28.						
Iron	mg/l	0.22	0.02	0.13	0.01	0.02	0.01		0.01		0.43	0.01		0.02	0.03						
Manganese	mg/l	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00		0.00	0.00						
Color		1.	1.	1.	1.	0.	0.		0.		7.	1.		0.	2.						
pH		7.8	7.5	7.5	7.7	7.6	7.7		7.6		7.7	8.1		7.6	7.0						
Specific Conductance	umhos/cm	439.	472.	521.	476.	474.	471.		509.		508.	502.		523.	505.						
Dissolved Solids																					
Residue at 180	mg/l	290.	311.	338.	302.	312.	312.		345.		330.	333.		332.	374.						
Calculated (sum)	mg/l	285.	301.	327.	305.	303.	304.		327.		327.	332.		336.	326.						
Hardness as CaCO3																					
Total	mg/l	168.	189.	216.	191.	189.	186.		208.		208.	210.		210.	210.						
Noncarbonate	mg/l	18.	35.	52.	36.	35.	28.		45.		41.	41.		39.	36.						
Alkalinity-CaCO3	mg/l	150.	154.	165.	156.	154.	157.		163.		167.	169.		167.	169.						
CO2 (calc)	mg/l	4.6	9.4	10.	6.1	7.5	6.1		8.0		6.5	2.7		8.2	33.						
SAR		1.0												0.8	0.8						
Langlier Index at 25														0.0	-0.5						
Cations																					
Calcium	mg/l	55.	59.	70.	62.	62.	59.		64.		66.	64.		63.	64.						
Magnesium	mg/l	7.5	10.	10.	8.9	8.4	9.5		12.		11.	12.		12.	11.						
Sodium	mg/l	29.	26.	24.	27.	27.	29.		28.		28.	28.		26.	27.						
Potassium	mg/l													2.7	2.7						
Anions																					
Bicarbonate	mg/l	183.	188.	201.	190.	188.	192.		199.		204.	206.		204.	206.						
Carbonate	mg/l	0.	0.	0.	0.	0.	0.		0.		0.	0.		0.	0.						
Sulfate	mg/l	51.	60.	65.	62.	61.	61.		65.		65.	65.		69.	61.						
Chloride	mg/l	13.	14.	16.	14.	14.	13.		17.		14.	14.		16.	15.						
Fluoride	mg/l	0.5	0.6	0.4	0.5	0.6	0.5		0.4		0.5	0.5		0.5	0.5						
Nitrate+Nitrite	mg/l	9.6	11.0	17.0	11.0	11.0	11.0		16.0		16.0	17.0		3.70							

Table D-4 Kirtland AFB Geochemical Data

WELL NO. 11-E

		1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Apr 1972	1973	Dec 1974	Nov 1975	1976	1977	1978
Silica	mg/l														28.		28.	26.			
Iron	mg/l														30.		0.08	2.1			
Manganese	mg/l														20.		0.00	0.04			
Color															0.		0.	0.			
pH															7.5		8.2	7.6			
Specific																					
Conductance	umhos/cm														569.		569.	586.			
Dissolved Solids																					
Residue at 180	mg/l														368.		354.	352.			
Calculated (sum)	mg/l														368.		358.	360.			
Hardness as CaCO3																					
Total	mg/l														210.		210.	230.			
Noncarbonate	mg/l														56.		44.	57.			
Alkalinity-CaCO3	mg/l														156.		162.	174.			
CO2 (calc)	mg/l																2.0	8.5			
SAR															1.0		1.1	0.8			
Langlier																					
Index at 25																	+0.6	+0.1			
Cations																					
Calcium	mg/l														65.		63.	71.			
Magnesium	mg/l														12.		12.	13.			
Sodium	mg/l														35.		35.	28.			
Potassium	mg/l														3.1		3.4	3.0			
Anions																					
Bicarbonate	mg/l														190.		198.	212.			
Carbonate	mg/l														0.		0.	0.			
Sulfate	mg/l														82.		76.	59.			
Chloride	mg/l														20.		20.	16.			
Fluoride	mg/l														0.7		0.6	0.5			
Nitrate+Nitrite	mg/l														35.5		5.0	8.90			

Table D.4A Supplemental Geochemical Data for KAFB - 1981

ANALYSES	WELL-1	WELL-3	WELL-11	WELL-12	WELL-13	WELL-14	EAST FIRE STATION	WEST FIRE STATION	LOUISIANA & GIBSON
Oil & Grease	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Ammonia as N	<0.20	0.20	0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrate as N	0.70	1.0	5.60	-	0.10	<0.10	0.90	0.10	-
Phosphurus	<0.10	<0.10	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10
Cyanide (Total)	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	<0.01
Phenols	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Cadmium	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.059
Calcium	45.1	40.8	59.7	-	29.0	33.4	40.8	33.3	36.1
Chromium (Total)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium VI	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	0.02	<0.02	<0.02	0.052	<0.02	<0.02	<0.02	<0.02	<0.02
Hardness	143.0	127.0	200.0	-	95.0	111.0	133.0	110.0	109.0
Iron	0.10	<0.10	<0.10	-	<0.10	<0.10	<0.10	<0.10	<0.10
Lead	0.109	<0.05	0.06	<0.05	<0.05	<0.05	0.086	0.064	<0.05
Magnesium	7.40	6.10	12.20	-	5.60	6.70	7.60	6.60	4.70
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	<0.002	<0.005	<0.005	<0.005	<0.005	<0.007	0.02	0.011	0.008
Bromoform	ND <0.3	ND <0.3		ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3
Bromodichloromethane	ND <0.3	ND <0.3	Broken	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3
Chloroform	ND <0.3	ND <0.3		ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3
Dibromochloromethane	ND <0.3	ND <0.3	in	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3
Methylene Chloride	ND <0.2	ND <0.2		ND <0.2	ND <0.2	ND <0.2	ND <0.2	ND <0.2	ND <0.2
1,1,2,2 - Tetrachloroethylene	TR <0.6	TR <0.6	Transit	TR <0.6	ND <0.3	ND <0.3	TR <0.6	TR <0.6	TR <0.6
1,1,1 - Trichloroethane	ND <0.3	ND <0.3		ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3
Trichloroethylene	ND <0.2	ND <0.2		ND <0.2	ND <0.2	ND <0.2	ND <0.2	ND <0.2	ND <0.2
Trihalomethane	ND <0.3	ND 0.3		ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3	ND <0.3

Note: All units in mg/l - = not measured.

Table D-5 Municipal/Other Well Geochemical Data*

Well Name	Atrisco Well #1	Atrisco Well #2	Atrisco Well #3	Atrisco Well #4	Atrisco Well #5	Atrisco Well #6	Atrisco Well #7	(Abandoned) Atrisco Well #8	(Abandoned) Atrisco Well #9	(Abandoned) Atrisco Well #11	(Abandoned) Atrisco Well #12
Latitude Longitude	35-04-45 106-41-00	35-04-45 106-41-00	35-04-45 106-41-00	35-04-45 106-41-00	35-04-30 106-41-00		35-04-30 106-41-00	35-04-30 106-41-00	35-04-45 106-41-30	35-04-45 106-41-00	35-04-45 106-41-00
ARSENIC	0.023	0.011(2)	0.018(2)	0.021	0.018	0.018	0.017	<0.040*	<0.01	0.06	0.05
BARIUM	<0.10	<0.10(2)	<0.11(2)	<0.10	<0.10	<0.10	<0.10	<0.500*	0.01	0.11	0.06
CADMIUM	<0.001	<0.006(2)	<0.004(3)	<0.01	<0.01	<0.01	<0.01	<0.010*	0.01	<0.01	<0.01
CHROMIUM	<0.01	<0.008(2)	<0.008(2)	<0.01	<0.01	<0.01	<0.01	<0.050*	<0.01	<0.01	<0.01
FLUORIDE	0.65	0.77(2)	0.73(3)	0.67(2)	0.33	0.63(2)	0.53	0.42*	0.87	0.52	0.34
LEAD	<0.01	<0.008(2)	<0.008(2)	<0.01	<0.01	<0.01	<0.01	<0.010*	<0.01	0.01	<0.01
MERCURY	<0.0005	<0.0010(2)	<0.0005(2)	<0.0005	<0.0005	<0.0005	<0.0005	----*	<0.0005	<0.0005	<0.0005
NITRATE	0.13	0.15(3)	0.27(4)	<0.13(3)	<0.01(2)	0.45(3)	0.04(3)	1.20*	0.23	0.01	<0.01(2)
SILVER	<0.01	<0.006(2)	<0.006(2)	<0.01	<0.01	<0.01	<0.01	<0.050*	<0.025	<0.025	<0.025
SELENIUM	0.0055	<0.007(3)	<0.005(3)	<0.005	<0.018(2)	<0.005	<0.005	0.03	0.05	0.03	0.04
GROSS ALPHA	0 ± 2.5(3)	0.0 ± 2.5(3)	0.0 ± 2.5(2)	0.0 ± 2.5	0.0 ± 2.5		0.0 ± 2.5(2)				
GROSS BETA	5 ± 4(3)	0.0 ± 2.0(3)	4 ± 3(2)	0.0 ± 2	0.0 ± 2		8 ± 5(2)				
RADIUM-226											
RADIUM-228											
ALKALINITY	158	124(2)	133(3)	154(2)	197	164(2)	115(2)	131.20*	128	122	127
BICARBONATE	192.5	150.8(2)	162.2(3)	187.6(2)	240.1	200.2(2)	140.5(2)	160.10*	153.2	148.3	154.6
CALCIUM	46.4	32.3(2)	33.87(3)	37.8(2)	64.8	39.7(2)	25.5(2)	26.00*	27.6	30.0	35.4
CARBONATE	0.0	0.0(2)	0.0(3)	0.0(2)	0.0	0.0(2)	0.0(2)	none *	0.0	0.0	0.0
CHLORIDE	20.8	14.4(2)	16.0(3)	19.9(2)	24.7	23.0(2)	13.7(2)	15.80*	17.5	16.4	10.6
COLOR	0.0	0.0(2)	3(3)	0.0(2)	0.0	10.0(2)	0.0(2)	none *	0.0	10.0	0.0
CONDUCTANCE	642	506(2)	523(3)	599(2)	779	652(2)	444(2)	455.00*	490	455	471
FOAMING AGENTS	<0.05	<0.05(2)	<0.05(3)	<0.05(2)	<0.05	<0.05(2)	<0.05(2)	<0.05*	<0.05	<0.05	<0.05
HARDNESS	168	108(2)	119(3)	130(2)	222	151(2)	87(2)	82.50*	87	96	119
IRON	<0.25	<0.25(2)	<0.58(3)	<0.25(2)	<0.25	<0.90(2)	<0.59(2)	<0.25*	<0.25	3.15	0.77
MAGNESIUM	12.8	6.7(2)	8.4(3)	8.6(2)	14.8	12.6(2)	5.7(2)	4.30*	4.5	5.1	7.6
MANGANESE	<0.05	<0.05(2)	<0.05(3)	<0.05(2)	<0.05	<0.05(2)	<0.05(2)	<0.05*	<0.05	0.05	<0.05
ODOR	none	none	none	none(2)	none	none (2)	none(2)	none *	none	none	none
pH	8.19	7.99(2)	8.13(3)	8.25(2)	8.15	8.14(2)	8.20(2)	8.14*	8.07	8.12	7.87
POTASSIUM	8.97	6.44(2)	6.76(3)	7.80	10.14	8.78(2)	6.83(2)	6.24*	6.24	8.19	7.8
SODIUM	73.6	54.1(2)	55.2(3)	71.3(2)	75.9	77.0(2)	55.2(2)	80.50*	64.4	52.9	41.4
SULFATE	129.7	79.5(2)	86.9(3)	100.5(2)	147.6	121.3(3)	76.4(2)	86.00*	87.3	78.0	80.6
T. FILT. RES.	470	328(2)	353(3)	409(2)	550	442(2)	317(2)	370.00*	305	290	335
TURBIDITY	0.4	1.3(2)	1.4(3)	0.7(2)	0.6	4.1(2)	1.1(2)	0.90*	2.0	36	3.7

* - 1974 d

Source: Pierce, 1980

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	Burton #2	Burton #3	Candelaria Well #1	Candelaria Well #2	Candelaria Well #3	Candelaria Well #4	Charles Well #1	Charles Well #2	Charles Well #3	Charles Well #4
Latitude Longitude	35-04-30 106-36-15	35-04-30 106-36-15					35-06-45 106-33-55	35-06-30 106-34-00	35-06-45 106-34-00	35-06-30 106-34-00
ARSENIC	0.026(2)	<0.020(3)	<0.008(2)	<0.008(2)	<0.008(2)	<0.008(2)	<0.01*	<0.01(2)	<0.01	<0.01
BARIUM	0.15(2)	0.14(3)	<0.12(2)	<0.10(2)	<0.13(2)	<0.11(2)	<0.5	<0.12(2)	<0.10	0.45
CADMIUM	<0.004(2)	<0.005(3)	<0.004(3)	<0.006(2)	<0.006(2)	<0.006(2)	<0.001	<0.01(2)	<0.01	<0.01
CHROMIUM	<0.008(2)	<0.008(3)	<0.008(2)	<0.008(2)	<0.008(2)	<0.008(2)	0.003	<0.01(2)	<0.01	<0.01
FLUORIDE	0.48(2)	0.47(3)	<0.008(2)	0.35(2)	0.47(2)	0.41(2)	0.41	0.48(3)	0.50	0.33
LEAD	<0.008(2)	<0.008(3)	<0.008(2)	<0.008(2)	<0.008(2)	<0.008(2)	0.003	<0.01(2)	<0.01	<0.01
MERCURY	<0.0005(2)	<0.0010(3)	<0.0005(2)	<0.0005(2)	<0.0005(2)	<0.0005(2)	<0.0005	<0.0005(2)	<0.0005	<0.0005
NITRATE	0.19(3)	0.30(5)	<0.53(3)	0.52(3)	0.49(3)	0.06(3)	0.18	0.05(4)	0.05(3)	0.31(2)
SILVER	<0.013(2)	<0.025(3)	<0.006(2)	<0.006(2)	<0.006(2)	<0.006(2)	<0.001	<0.018(2)	<0.01	<0.01
SELENIUM	<0.005	<0.005	<0.005(3)	0.007(2)	<0.006(2)	<0.006(2)	<0.005	<0.005	<0.005	<0.005
GROSS ALPHA	0.0 ± 2.5(2)	0.0 ± 2.5(5)	0.0 ± 2.5(3)	0.0 ± 2.5	0.0 ± 2.5(2)		0.0 ± 2.5	0.0 ± 2.5(4)	0.0 ± 2.5(2)	1.4 ± 2.6(5)
GROSS BETA	3 ± 3(2)	0.0 ± 2(5)	2.3 ± 2.7(3)	11 ± 5	0.0 ± 2.0(2)		0.0 ± 2	0.0 ± 2(4)	0.0 ± 2(2)	3.0 ± 3.0(5)
RADIUM-226										
RADIUM-228										
ALKALINITY	106(2)	108(3)	143(2)	133(2)	110(2)	142(2)	118	110(2)	107(2)	117
BICARBONATE	128.6(2)	131.5(3)	174.5(2)	162.2(2)	133.7(2)	173.1(2)	143.4	133.8(2)	130.1(2)	143.0
CALCIUM	35.8(2)	38.9(3)	57.8(2)	83.6(2)	55.3(2)	89.6(2)	42.4	38.9(2)	36.5(2)	48.6
CARBONATE	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)	0.0	0.0(2)	0.0(2)	0.0
CHLORIDE	20.9(2)	22.4(3)	17.9(2)	33.4(2)	23.0(2)	43.0(2)	33.8	8.8(2)	7.9(2)	36.9
COLOR	0.0(2)	0.0(3)	0.0(2)	0.0(2)	0.0(2)	0.0(2)	0.0	0.0(2)	0.0(2)	0.0
CONDUCTANCE	360(2)	379(3)	549(2)	733(2)	504(2)	786(2)	415	316(2)	307(2)	424
FOAMING AGENTS	<0.05(2)	<0.05(3)	<0.05(2)	<0.05(2)	<0.05(2)	<0.05(2)	<0.05	<0.05(2)	<0.05(2)	<0.05
HARDNESS	122(2)	127(3)	191(2)	260(2)	176(2)	286(2)	123	115(2)	113(2)	141
IRON	<0.25(2)	<0.31(3)	<0.25(2)	<0.25(2)	<0.25(2)	<0.25(2)	<0.25	<0.25(2)	<0.25(2)	<0.25
MAGNESIUM	7.9(2)	7.3(3)	11.1(2)	12.0(2)	9.0(2)	15.0(2)	4.3	4.2(2)	5.4(2)	4.8
MANGANESE	<0.05(2)	<0.05(3)	<0.05(2)	<0.06(2)	<0.05(2)	<0.05(2)	<0.05	<0.05(2)	<0.05(2)	<0.05
ODOR	none(2)	none(3)	none(2)	none(2)	none(2)	none(2)	none	none(2)	none(2)	none
pH	8.11(2)	8.03(3)	8.14(2)	8.13(2)	8.06(2)	7.92(2)	8.02	7.97(2)	7.89(2)	8.07
POTASSIUM	3.90(2)	4.16(3)	8.00(2)	7.02(2)	6.44(2)	8.68(2)	2.34	2.16(2)	2.34(2)	2.73
SODIUM	21.9(2)	24.5(3)	34.5(2)	38.0(2)	28.75(2)	39.1(2)	34.5	21.9(2)	19.6(2)	29.9
SULFATE	34.2(2)	43.1(3)	94.3(2)	164.9(2)	96.2(2)	176.5(2)	26.4	33.3(2)	30.9(2)	30.7
T. FILT. RES.	227(2)	239(3)	380(2)	480(2)	346(2)	514(2)	215	218(2)	177(2)	255
TURBIDITY	0.2(2)	0.2(3)	0.7(2)	0.8(2)	0.6(2)	0.7(2)	0.1	0.5(2)	0.3(2)	0.3

* - 1974

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	Duranes Well #1	Duranes Well #2	Duranes Well #3	Duranes Well #4	Duranes Well #5	Duranes Well #6	Duranes Well #7	Griegos Well #1	Griegos Well #2	Griegos Well #3	Griegos Well #4
Latitude Longitude	35-06-15 106-37-10	35-07-30 106-40-35	35-06-45 106-40-35	35-06-45 106-40-35	35-06-15 106-40-40	35-07-20 106-40-45	35-06-45 106-40-45	35-08-30 106-40-20	35-08-00 106-39-45	35-08-10 106-40-20	35-08-30 106-38-35
ARSENIC	0.015(2)	<0.008(2)	0.005	0.016(2)	0.024	0.015(2)	0.023	0.014 (3)	0.014 (2)	0.02	0.019 (2)
BARIUM	<0.10(2)	<0.11(2)	<0.10	<0.10(2)	<0.10	<0.11(2)	<0.10	<0.10 (2)	<0.10 (2)	<0.10	<0.10 (2)
CADMIUM	<0.006(2)	<0.006(2)	<0.001	<0.006(2)	<0.01	<0.006(2)	<0.01	<0.006 (2)	<0.006 (2)	<0.01	<0.006 (2)
CHROMIUM	<0.008(2)	<0.008(2)	<0.005	<0.008(2)	<0.01	<0.008(2)	<0.01	<0.008 (2)	<0.008 (2)	<0.01	<0.008 (2)
FLUORIDE	0.60(2)	0.57(2)	0.48	0.91	0.93(2)	0.36(2)	0.75	0.37 (2)	0.32 (2)	0.46	0.56 (2)
LEAD	<0.008(2)	<0.008(2)	<0.005	<0.008(2)	<0.01	<0.008(2)	<0.01	<0.008 (2)	<0.008 (2)	<0.01	<0.008 (2)
MERCURY	<0.010(2)	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.0005 (2)	<0.0008 (2)	<0.001	<0.001
NITRATE	0.13(3)	0.06(3)	0.06	0.09(3)	0.54(3)	0.07(3)	0.08	<0.02 (3)	<0.03 (3)	0.05 (2)	<0.03 (3)
SILVER	<0.006(2)	<0.006(2)	0.001	<0.006(2)	<0.01	<0.006(2)	<0.01	<0.006 (2)	<0.006 (2)	<0.01	<0.006 (2)
SELENIUM	0.013(2)	<0.010(2)	0.002	<0.001	<0.005	<0.001	<0.005	<0.001	<0.001	<0.005	<0.005
GROSS ALPHA	0.0 ± 2.5(4)	0.0 ± 2.5					0.0 ± 2.5(4)	4.5 ± 4.3 (2)			
GROSS BETA	2.5 ± 3.2(4)	0.0 ± 2					0.0 ± 2.0(4)	8.5 ± 3.8(2)			
RADIUM -226								<0.1			
RADIUM-228											
ALKALINITY	140(2)	125(2)	139	115(2)	127(2)	159(2)	123	121 (2)	161 (2)	121	119 (2)
BICARBONATE	170.6(2)	151.8(2)	169.8	140.2(2)	154.7(2)	194.0(2)	149.6	147.3 (2)	195.4 (2)	146.9	145.3 (2)
CALCIUM	40.8(2)	27.9(2)	42.2	25.0(2)	26.0(2)	48.1(2)	29.6	41.8 (2)	54.8 (2)	29.2	31.5 (2)
CARBONATE	0.0(2)	0.0(2)	0.0	0.0(2)	0.0(2)	0.0(2)	0.0	0.0 (2)	0.0 (2)	0.0	0.0 (2)
CHLORIDE	18.5(2)	11.2(2)	14.8	16.5(2)	14.9(2)	15.8(2)	13.5	14.5 (2)	16.[illegible] (2)	12.1	12.6 (2)
COLOR	0.0(2)	0.0(2)	0.0	0.0(2)	0.0(2)	0.0(2)	0.0	0.0 (2)	0.0 (2)	0.0	0.0 (2)
CONDUCTANCE	604(2)	460(2)	584	490(2)	488(2)	557(2)	461	440 (2)	589 (2)	404	399 (2)
FOAMING AGENTS	<0.05(2)	<0.05(2)	<0.05	<0.05(2)	<0.05(2)	<0.05(2)	<0.05	<0.05 (2)	<0.05 (2)	<0.05	<0.05 (2)
HARDNESS	150(2)	100(2)	146	90(2)	92(2)	172(2)	118	153 (2)	286 (2)	109	121 (2)
IRON	<0.25(2)	<0.25(2)	<0.25	<0.25(2)	<0.25(2)	<0.25(2)	<0.25	<0.25 (2)	<0.25 (2)	<0.25	<0.28 (3)
MAGNESIUM	11.6(2)	7.4(2)	9.9	6.8(2)	6.5(2)	12.5(2)	10.6	11.7 (2)	15.9 (2)	8.8	10.4 (2)
MANGANESE	<0.05(2)	<0.05(2)	0.07	<0.05(2)	<0.05(2)	<0.05(2)	<0.05	<0.05 (2)	<0.05 (2)	<0.05	<0.05 (2)
ODOR	none(2)	none(2)	none	none(2)	none(2)	none(2)	none	none (2)	none (2)	none	none (2)
pH	7.98(2)	8.09(2)	7.76	8.10(2)	8.24(2)	8.06(2)	8.21	8.11 (2)	8.05 (2)	8.19	8.12 (2)
POTASSIUM	9.36(2)	6.83(2)	7.80	6.24(2)	6.44(2)	9.36(2)	7.22	8.19 (2)	10.14 (2)	7.02	7.61 (2)
SODIUM	64.4(2)	49.5(2)	52.9	65.2(2)	61.0(2)	41.4(2)	55.2	27.1 (2)	39.1 (2)	46.0	32.2 (2)
SULFATE	117.0(2)	74.0(2)	98.6	80.8(2)	72.7(2)	90.3(2)	84.5	64.9 (2)	103.5 (2)	68.2	45.8 (2)
T. FILT. RES.	412(2)	316(2)	382	335(2)	333(2)	396(2)	335	302 (2)	413 (2)	300	280 (2)
TURBIDITY	0.2(2)	0.2(2)	0.3	0.5(2)	0.4(2)	0.2(2)	0.5	0.5 (2)	0.5 (2)	1.0	0.4 (2)

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	Griegos Well #5	Leavitt Well #1	Leavitt Well #2	Lomas Well #1	Lomas Well #2	Lomas Well #3	Lomas Well #4	Love Well #1	Love Well #2	Love Well #3
Latitude	35-08-30			35-04-30				35-05-10	35-05-00	35 05 15
Longitude	106-38-35			106-30-30				106-31-55	106-32-08	106-32-22
ARSENIC	0.017 (2)	0.02 (2)	<0.03 (4)	<0.013 (2)	<0.005	<0.008 (2)	<0.008 (3)	0.011	<0.01	<0.01
BARIUM	<0.12 (2)	<0.10 (2)	<0.07 (4)	<0.08 (2)	0.24	<0.32 (2)	<0.13 (2)	0.12	<0.05	0.18
CADMIUM	<0.056 (2)	<0.006 (2)	<0.008 (4)	<0.006 (2)	0.01	0.001	<0.007 (2)	<0.005	<0.01	<0.005
CHROMIUM	<0.008 (2)	<0.008 (2)	<0.015 (4)	<0.005 (2)	<0.005	<0.013 (2)	<0.008 (2)	<0.01	<0.005	<0.01
FLUORIDE	0.41 (2)	1.32 (2)	1.45 (3)	0.48	0.61	0.67 (2)	0.72 (2)	0.67	0.63	0.66 (2)
LEAD	<0.008 (2)	<0.009 (3)	<0.009 (5)	<0.008 (2)	<0.005	<0.008 (2)	<0.012 (2)	<0.01	<0.01	0.03
MERCURY	<0.001 (2)	<0.0006 (2)	<0.0005 (4)	<0.0005 (2)	<0.0005	<0.0005 (2)	<0.0005 (2)	<0.0005	<0.0005	<0.0005
NITRATE	<0.02 (3)	1.53 (3)	1.71 (4)	2.00	1.00	0.62 (3)	0.67 (4)	0.45 (3)	0.50	0.39 (3)
SILVER	<0.006 (2)	<0.006 (2)	<0.015 (4)	<0.013 (2)	<0.001	<0.006 (2)	<0.013 (2)	<0.025	<0.025	<0.025
SELENIUM	0.014 (2)	<0.007 (2)	0.006 (2)	0.002	<0.001	0.006 (2)	<0.007 (3)	<0.012	0.01	0.01
GROSS ALPHA	0.0 ± 2.5	0.0 ± 2.5(3)	0.0 ± 2.5(4)	0.0 ± 2.5		0.0 ± 2.5(3)	0.0 ± 2.5(3)	0.0 ± 2.5(3)		0.0 ± 2.5
GROSS BETA	13 ± 5	0.0 ± 2 (3)	0.0 ± 2.0(4)	0.0 ± 2		0.0 ± 2 (3)	0.0 ± 2.0(3)	1.7 ± 2.7(3)		0.0 ± 2.0
RADIUM-226										
RADIUM-228										
ALKALINITY	167 (2)	137 (2)	141 (3)	159	116	120 (2)	121 (2)	120 (2)	118	108 (2)
BICARBONATE	204.0 (2)	159.9 (2)	156.1 (3)	194.4	141.5	146.8 (2)	146.9 (2)	147.5 (2)	144.2	131.8 (2)
CALCIUM	49.8 (2)	7.3 (2)	8.5 (3)	62.8	39.2	40.9 (2)	21.2 (2)	32.6 (2)	30.4	26.6 (2)
CARBONATE	0.0 (2)	3.6 (2)	7.5 (3)	0.0	0.0	0.0 (2)	0.0 (2)	0.0 (2)	0.0	0.0 (2)
CHLORIDE	18.2 (2)	14.2 (2)	27.0 (3)	13.1	9.8	8.6 (2)	7.2 (2)	15.4 (2)	7.1	12.1 (2)
COLOR	0.0 (2)	0.0 (2)	0.0 (3)	0.0	0.0	0.0 (2)	0.0 (2)	0.0 (2)	0.0	0.0 (2)
CONDUCTANCE	600 (2)	458 (2)	619 (3)	520	368	374 (2)	11 (2)	394 (2)	324	299 (2)
FOAMING AGENTS	<0.05 (2)	<0.05 (2)	<0.05 (3)	<0.05	<0.05	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05	<0.05 (2)
HARDNESS	187 (2)	25 (2)	13 (4)	193 (2)	113	121 (2)	17 (2)	106 (2)	90 (2)	99 (2)
IRON	<0.29 (2)	<0.25 (2)	<0.30 (5)	<0.18 (3)	<0.25	<0.27 (2)	0.25 (2)	<0.27 (2)	<0.25 (2)	<0.25 (2)
MAGNESIUM	16.2 (2)	1.7 (2)	1.3 (3)	9.4	3.5	4.5 (2)	10.6 (2)	5.9 (2)	3.1	7.9 (2)
MANGANESE	<0.05 (2)	<0.05 (2)	<0.05 (5)	<0.05 (3)	<0.05	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)
ODOR	none (2)	none (2)	none (3)	none	none	none (2)	none (2)	none (2)	none	none (2)
pH	8.02 (2)	8.47 (2)	8.67 (3)	7.93	7.70	7.97 (2)	8.02 (2)	8.06 (2)	8.11	8.10 (2)
POTASSIUM	9.75 (2)	1.56 (2)	0.91 (3)	3.90	2.34	2.54 (2)	1.76 (2)	1.95 (2)	2.73	2.34 (2)
SODIUM	47.2 (2)	87.4 (2)	125.4 (4)	27.6	29.9	31.1 (2)	29.9 (2)	44.7 (2)	32.2	24.2 (2)
SULFATE	96.2 (2)	60.6 (2)	95.1 (3)	67.0	36.2	45.3 (2)	21.2 (2)	50.6 (2)	23.2	17.0 (2)
T. FILT. RES.	409 (2)	296 (2)	406 (4)	313 (2)	229	230 (2)	82 (2)	219 (2)	200 (2)	172 (2)
TURBIDITY	1.1 (2)	0.5 (2)	0.5 (3)	0.2	1.5	1.8 (2)	0.4 (2)	1.2 (2)	0.3	0.3 (2)

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	Love Well #4	Love Well #5	Love Well #6	Love Well #7	Montessa Park Well #1	Police Farm Well #1	Ridgecrest Well #1	Ridgecrest Well #2	Ridgecrest Well #3	San Jose Well #1
Latitude	35-05-10	35-05-00					35-07-45			35-03-10
Longitude	106-33-00	106-32-40					106-32-30			106-38-50
ARSENIC	<0.005	<0.018 (2)	<0.005	<0.01	<0.005	<0.01	<0.007 (2)	<0.005	<0.005	<0.01
BARIUM	0.25	<0.09 (2)	<0.5	0.17	<0.10	<0.5	<0.3 (2)	0.11	0.23	0.22
CADMIUM	<0.005	<0.008 (2)	<0.001	<0.005	<0.001	<0.01	<0.006 (2)	<0.001	<0.001	<0.005
CHROMIUM	<0.01	<0.01 (2)	<0.001	<0.01	0.005	<0.01	<0.008 (2)	<0.005	<0.005	<0.01
FLUORIDE	0.43	0.54 (3)	0.79	0.58 (2)	0.44	0.42	0.65 (2)	0.56	0.45	0.30
LEAD	<0.01	<0.01 (2)	0.013	<0.01	<0.005	<0.01	<0.008 (2)	<0.005	0.010	<0.01
MERCURY	0.0005	<0.0005 (2)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005 (2)	<0.0005	<0.0005	<0.0005
NITRATE	0.24	0.35 (4)	0.34	0.26 (3)	0.19	0.05 (2)	0.75 (3)	0.30	0.18	0.20 (2)
SILVER	<0.025	<0.025 (2)	<0.001	<0.025	<0.001	<0.01	<0.006 (2)	<0.001	<0.001	<0.025
SELENIUM		<0.005		<0.01	<0.001	<0.01	<0.006 (2)	0.003	0.003	<0.005
GROSS ALPHA		0.0 ± 2.5		0.0 ± 2.5(2)	6.0 ± 3.7(3)		0.0 ± 2.5(3)	0.0 ± 2.5	0.0 ± 2.5(2)	0.0 ± 2.5
GROSS BETA		0.0 ± 2		0.0 ± 2.0(2)	3.0 ± 3.0(3)		1 ± 3 (3)	0.0 ± 2.0	0.0 ± 2.0(2)	7 ± 4
RADIUM-226					<0.05					
RADIUM-228										
ALKALINITY	106	107 (2)	104	105 (2)	104	100	141 (2)	105	114	156
BICARBONATE	129.7	130.6 (2)	127.2	127.4 (2)	126.9	122.5	172.2 (2)	127.7	138.7	190.8
CALCIUM	44.8	35.7 (2)	24.4	34.9 (2)	33.2	34.4	50.0 (2)	36.0	41.6	64.8
CARBONATE	0.0	0.0 (2)	0.0	0.0 (2)	0.0	0.0	0.0 (2)	0.0	0.0	0.0
CHLORIDE	39.8	19.4 (2)	5.6	14.4 (2)	7.7	6.3	9.9 (2)	27.3	28.5	34.9
COLOR	0.0	0.0 (2)	0.0	0.0 (2)	0.0	0.0	0.0 (2)	0.0	0.0	0.0
CONDUCTANCE	388	321 (2)	270	297 (2)	296	288	457 (2)	349	391	760
FOAMING AGENTS	<0.05	<0.05 (2)	<0.05	<0.05 (2)	<0.05	<0.05	<0.05 (2)	<0.05	<0.05	<0.05
HARDNESS	136	109 (2)	63	101 (2)	106	112	155 (2)	112	117	283
IRON	<0.25	<0.25 (2)	<0.25	<0.25 (2)	<0.25	1.04	<0.25 (2)	<0.25	<0.25	0.18
MAGNESIUM	6.0	4.8 (2)	0.5	3.3 (2)	4.6	6.3	7.2 (2)	5.5	3.2	29.5
MANGANESE	<0.05	<0.05 (2)	<0.05	<0.05 (2)	<0.05	<0.05	<0.05 (2)	<0.05	<0.05	<0.05
ODOR	none	none (2)	none	none (2)	none	none	none (2)	none	none	none
pH	8.18	8.15 (2)	8.11	8.09 (2)	8.11	8.01	7.96 (2)	8.03	7.88	8.13
POTASSIUM	2.73	2.93 (2)	1.95	2.34 (2)	1.95	3.12	2.54 (2)	2.73	3.51	11.70
SODIUM	25.3	23.0 (2)	32.2	23.0 (2)	20.7	18.4	26.5 (2)	25.3	25.3	36.8
SULFATE	21.7	17.4 (2)	12.7	17.7 (2)	30.1	30.2	52.5 (2)	20.1	26.4	159.4
T. FILT. RES.	250	165 (2)	142	160 (2)	198	185	264 (2)	209	234	515
TURBIDITY	0.2	0.2 (2)	0.1	0.2 (2)	0.3	10.0	0.5 (2)	0.1	0.4	0.2

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	(Abandoned) San Jose Well #2	San Jose Well #3	San Jose Well #4	San Jose Well #5	San Jose Well #6	Thomas Well #1	Thomas Well #2	Thomas Well #3	Thomas Well #4	Volandia Well #1
Latitude Longitude	35-03-00 106-38-50	35-03-00 106-38-35		35-03-00 106-38-25		35-07-45 106-33-10	35-07-45 106-33-10	35-09-20 106-33-20	35-09-20 106-33-10	35-08-55 106-35-00
ARSENIC	<0.01	<0.008 (2)	<0.023 (2)	<0.022 (2)	<0.008 (2)	<0.008 (2)	<0.006 (2)	<0.01	<0.008 (2)	<0.008 (2)
BARIUM	0.10	<0.10 (2)	0.13 (2)	0.12 (2)	<0.11 (2)	0.25 (2)	0.23 (2)	0.11	0.21 (2)	<0.13 (2)
CADMIUM	<0.005	<0.006 (2)	<0.003 (2)	<0.003 (2)	<0.003 (2)	<0.003 (2)	<0.003 (2)	<0.005	<0.004 (2)	<0.006 (2)
CHROMIUM	<0.01	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.01	<0.008 (2)	<0.008 (2)
FLUORIDE	0.67	0.63 (2)	0.76 (2)	0.77 (2)	0.42 (2)	0.42 (2)	0.50 (2)	0.56	0.53 (2)	0.44 (2)
LEAD	<0.01	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.008 (2)	<0.01	<0.013 (2)	<0.008 (2)
MERCURY	0.0005	<0.0005 (2)	<0.0005 (2)	<0.0005 (2)	<0.0005 (2)	<0.0005 (2)	<0.0005 (2)	0.0006	<0.0005 (2)	<0.0013 (2)
NITRATE	1.33 (2)	0.45 (3)	0.41 (3)	0.50	0.16 (3)	0.25 (3)	0.09 (3)	0.19	0.09 (3)	<0.03 (2)
SILVER	<0.025	<0.006 (2)	<0.013 (2)	<0.013 (2)	<0.013 (2)	<0.013 (2)	<0.013 (2)	<0.025	<0.013 (2)	<0.006 (2)
SELENIUM	0.028	0.010 (2)	<0.001	<0.001	<0.001	0.006 (2)	<0.001	0.01	<0.006 (2)	<0.006 (2)
GROSS ALPHA			0.0 ± 2.5 (3)		0.0 ± 2.5 (3)	0.0 ± 2.5 (2)	0.0 ± 2.5		0.0 ± 2.5 (3)	0.0 ± 2.5
GROSS BETA			2 ± 3 (3)		1.6 ± 2.8 (3)	4 ± 3 (2)	0.0 ± 2		0.0 ± 2.0 (3)	0.0 ± 2
RADIUM-226										
RADIUM-228										
ALKALINITY	101	102 (2)	110 (2)	112 (2)	129 (2)	131 (2)	122 (2)	123	129 (2)	98 (2)
BICARBONATE	122.7	124.5 (2)	133.6 (2)	136.9 (2)	157.7 (2)	159.4 (2)	148.5 (2)	150.3	157.0 (2)	119.2 (2)
CALCIUM	24.8	27.8 (2)	31.8 (2)	20.0 (2)	66.6 (2)	36.0 (2)	42.2 (2)	40.8	63.5 (2)	34.1 (2)
CARBONATE	0.0	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0	0.0 (2)	0.0 (2)
CHLORIDE	38.4	34.0 (2)	29.4 (2)	19.2 (2)	38.8 (2)	55.7 (2)	74.7 (2)	53.1	106.1 (2)	7.7 (2)
COLOR	0.0	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0	0.0 (2)	0.0 (2)
CONDUCTANCE	420	421 (2)	426 (2)	436 (2)	690 (2)	493 (2)	548 (2)	500	693 (2)	289 (2)
FOAMING AGENTS	<0.05	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05	<0.05 (2)	<0.05 (2)
HARDNESS	114	99 (2)	119 (2)	74 (2)	261 (2)	149 (2)	155 (2)	159	185 (2)	106 (2)
IRON	<0.25	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.25	<0.25 (2)	<0.25 (2)
MAGNESIUM	12.8	7.1 (2)	9.2 (2)	5.9 (2)	22.8 (2)	14.4 (2)	12.0 (2)	14.0	6.4 (2)	6.0 (2)
MANGANESE	<0.05	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05	<0.05 (2)	<0.05 (2)
ODOR	none	none (2)	none (2)	none (2)	none (2)	none (2)	none (2)	none	none (2)	none (2)
pH	8.26	7.94 (2)	8.04 (2)	8.24 (2)	7.97 (2)	8.00 (2)	8.09 (2)	8.06	8.06 (2)	7.80 (2)
POTASSIUM	8.97	8.88 (2)	8.78 (2)	7.02 (2)	9.75 (2)	2.54 (2)	2.34 (2)	2.34	2.73 (2)	2.15 (2)
SODIUM	41.4	40.3 (2)	38.0 (2)	59.8 (2)	27.6 (2)	39.1 (2)	46.0 (2)	39.1	57.5 (2)	18.4 (2)
SULFATE	54.9	41.8 (2)	49.2 (2)	64.7 (2)	146.5 (2)	25.7 (2)	26.8 (2)	39.5	29.4 (2)	29.9 (2)
T. FILT. RES.	290	299 (2)	256 (2)	301 (2)	475 (2)	294 (2)	312 (2)	310	395 (2)	183 (2)
TURBIDITY	2.2	0.7 (2)	0.2 (2)	0.2 (2)	0.2 (2)	0.2 (2)	0.2 (2)	0.2	0.3 (2)	0.9 (2)

Table D-5 Municipal/Other Well Geochemical Data (Continued)

Well Name	Volandia Well #2	Vol Andia Well #3	Vol Andia Well #4	Vol Andia Well #5	Vol Andia Well #6	West Mesa Well #1	West Mesa Well #2	West Mesa Well #3	West Mesa Well #4	(Abandoned) Yale Well #1
Latitude / Longitude	35-08-10 / 106-35-00	35-07-45 / 106-36-10	35-08-53 / 106-05-20	35-08-20 / 106-36-00	35-08-30 / 106-35-22	35-04-30 / 106-44-00	35-04-30 / 106-44-00			35-05 21 / 106-07-00
ARSENIC	<0.008 (2)	0.02	<0.01 (2)	<0 01	<0.01	0.022	0.014	0.031	0.018	0.01
BARIUM	<0.12 (2)	<0.05	<0.11 (2)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.18
CADMIUM	<0.007 (2)	<0.01	<0.006 (2)	<0.01	<0.01	<0.01	<0.01	<0.001	<0.001	<0.005
CHROMIUM	<0.008 (2)	<0.005	<0.008 (2)	<0.01	<0.01	0.02	0.02	<0.005	<0.005	<0.01
FLUORIDE	0.44 (2)	0 44	0.43 (2)	0.41	0.41	1.00 (2)	0.85 (2)	1.21	1.19	0.48 (2)
LEAD	<0.008 (2)	<0.01	<0.008 (2)	<0.01	<0.01	<0.01	<0.01	0.010	<0 005	<0.01
MERCURY	<0.0005 (2)	<0.0005	<0.0005(2)	<0.0005	<0.0005	<0.0005	<0.0005	0.0010	0.0005	0.0005
NITRATE	0.07 (3)	0.60*	<0.05 (3)	0.14 (3)	0.10	1.72 (3)	<1.11 (2)	2.45	1.19	0.20 (3)
SILVER	<0.006 (2)	<0.025	<0.006 (2)	<0.01	<0.01	<0.01	<0.01	<0.001	<0.001	<0.025
SELENIUM	<0.007 (3)	<0.005	<0.006 (2)	<0.01	<0.01	<0.01	<0.01	0.002	0.002	0.016
GROSS ALPHA	0.0 ± 2.5(4)	0.0 ± 2.5(2)				0.0 ± 2.5(2)	0.0 ± 2.5		0.0 ± 2.5(4)	0 0 ± 2.5(2)
GROSS BETA	0.0 ± 2.0(4)	0.0 ± 2.0(2)				0.0 ± 2 (2)	0.0 ± 2.0		1.5 ± 2.5(4)	5 ± 4 (2)
RADIUM-226										
RADIUM-228										
ALKALINITY	100 (2)	97*	99 (2)	97 (2)	106 (2)	153 (2)	145 (2)	144	135	97 (2)
BICARBONATE	121.3 (2)	118.6*	120.4 (2)	118.6 (2)	129.2 (2)	165.1 (2)	166.9 (2)	172.3	165.2	118.4 (2)
CALCIUM	37.1 (2)	33.0*	36.5 (2)	35.3 (2)	36.2 (2)	3.5 (2)	21.9 (2)	5.0	8.4	35.5 (2)
CARBONATE	0.0 (2)	0.0*	0.0 (2)	0.0 (2)	0.0 (2)	10.2 (2)	4.5 (2)	1.9	0.0	0.0 (2)
CHLORIDE	7.6 (2)	13 8*	7.9 (2)	8.3 (2)	6.8 (2)	8.7 (2)	13.3 (2)	8.3	11.6	18.3 (2)
COLOR	0.0 (2)	0.0*	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0	0.0	0.0 (2)
CONDUCTANCE	296 (2)	280*	292 (2)	294 (2)	291 (2)	509 (2)	493 (2)	422	492	329 (2)
FOAMING AGENTS	<0.05 (2)	<0.05*	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05	<0.05	<0.05 (2)
HARDNESS	115 (2)	106	113 (2)	112 (2)	112 (2)	13 (2)	63 (2)	20	31	119 (2)
IRON	<0.25 (2)	<0.15 (2)	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.25 (2)	<0.45 (2)	<0.25	<0.25	<0 25 (2)
MAGNESIUM	5.3 (2)	4.9*	5.4 (2)	5.7 (2)	5.2 (2)	0.9 (2)	1.8 (2)	1.8	2.3	7.3 (2)
MANGANESE	<0.06 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.05 (2)	<0.06 (2)	<0.05	<0.05	<0.05 (2)
ODOR	none (2)	none*	none (2)	none (2)	none (2)	none (2)	none (2)	none	none	none (2)
pH	8.06 (2)	7.85*	8.09 (2)	8.06 (2)	7.93 (2)	8.76 (2)	8.39 (2)	8.45	8.04	8.15 (2)
POTASSIUM	1.95 (2)	2.34*	2.15 (2)	2.34 (2)	1.95 (2)	0.78 (2)	4.10 (2)	1.56	1.95	4.10 (2)
SODIUM	16.1 (2)	18 4*	16.1 (2)	17.3 (2)	16.1 (2)	105.6 (2)	74.8 (2)	89.7	89.7	19 6 (2)
SULFATE	32.8 (2)	27.4*	28.8 (2)	35.2 (2)	31.2 (2)	72.3 (2)	80.3 (2)	42.5	55.7	36.7 (2)
T. FILT. RES.	193 (2)	165	181 (2)	207 (2)	188 (2)	315 (2)	325 (2)	266	292	205 (2)
TURBIDITY	0.9 (2)	0.2*	0.8 (2)	0.7 (2)	0.2 (2)	0.3	1.8 (2)	0.2	0.3	0.2 (2)

Table D-5 Municipal/Other WEll Geochemical Data (Concluded)

Well Name	Yale Well #2	Yale Well #3
Latitude Longitude		
ARSENIC	0.02	<0.01
BARIUM	<0.05	0.14
CADMIUM	<0.01	<0.005
CHROMIUM	<0.005	<0.01
FLUORIDE	0.49	0.54
LEAD	<0.01	<0.01
MERCURY	<0.0005	<0.0005
NITRATE		0.23
SILVER	<0.025	<0.025
SELENIUM	<0.005	<0.005
GROSS ALPHA	0.0 ± 2.5(4)	
GROSS BETA	2.7 ± 3.5(4)	
RADIUM-226		
RADIUM-228		
ALKALINITY	93	112 (2)
BICARBONATE	113.0	136.0 (2)
CALCIUM	31.0	31.0 (2)
CARBONATE	0.0	0.0 (2)
CHLORIDE	9.7	20.5 (2)
COLOR	0.0	0.0 (2)
CONDUCTANCE	297	382 (2)
FOAMING AGENTS	<0.05	<0.05 (2)
HARDNESS	100 (2)	110 (2)
IRON	<0.25 (2)	<0.25 (2)
MAGNESIUM	1.1	7.9 (2)
MANGANESE	<0.05 (2)	<0.05 (2)
ODOR	none	none (2)
pH	8.07	8.13 (2)
POTASSIUM	4.68	6.83 (2)
SODIUM	18.4	31.1 (2)
SULFATE	24.5	39.1 (2)
T. FILT. RES.	239 (2)	272 (2)
TURBIDITY	0.4	0.3 (2)

APPENDIX E
Field Data

The data below were gathered by Molzin-Corbin and Associates in 1977 during the course of engineering studies for the Tijeras Interceptor. The Tijeras Interceptor is a sanitary sewer line owned and operated by the City of Albuquerque. This pipeline crosses the northern portion of LF-02.

Borehole locations were determined relative to station 50+ 00 (shown on the following page) and transferred to Figure 1.6 and 1.7. These data were not generated the KAFB IRP Phase II field program.

SANITARY LANDFILL TEST HOLE INFORMATION

Approximate Station	Landfill Soil Cover		Landfilled Refuse		Natural Soil
	From -To ft	Thickness ft	From -To ft	Thickness ft	Reached At ft
41+00					0
43+50					0
44+60					0
46+50	0-4	4	4-13	9	13
48+00	0-6	6	6-14	8+	?
48+80	0-4	4	4-16	12+	?
49+50	0-2	2	2-15	13+	?
51+00					0
51+75					0
53+50					0

Reference Map for Molzen-Corbin, 1977 Drilling

SCIENCE APPLICATIONS, INC.
505 Marquette Avenue N.W.
Albuquerque, New Mexico 87102

BORING No. DM-01
DEPTH DRILLED 480 ft, BGS
SCREENED FORMATION(S) QTsf

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33
SURVEY DATA (Coord) 39989.91 ft E; 1470.29 ft N
TOP of PIPE ELEV. 5319.58 (ft, MSL) GROUND ELEV. 5318.42 (ft, MSL)

DRILLING

DRILLER Rodgers & Co RIG TYPE Gardner Denver 1000
START 22 December 1983 END 30 December 1983
BIT SCHEDULE 8 3/4" Retipped Soft Formation Tricone 0-480 ft, BGS
DRILLING FLUIDS Baroid "Quik Gel" Bentonite drilling mud.

WATER ENCOUNTERED AT Approx. 430 ft. BGS

CONSTRUCTION

CASING SCHEDULE All casing flush threaded 5.5 inch OD sch 40 PVC. 0-415 ft, solid; 415-465 ft, 0.020" slot screen; 465-475 ft, solid; threaded end cap.

BACKFILL SCHEDULE 0-406 ft(?) natural material backfill; 406(?)-409 ft Bentonite pellet seal (20 lb), 409-475 ft 10-20 Silica Sand (1700 lb), 475-480 ft caved.

GEOPHYSICAL LOGS None

COMMENTS Locking steel cap set in concrete at well head. See Lt. Col. Robinson (1606th ABW/SGPBE, KAFB)

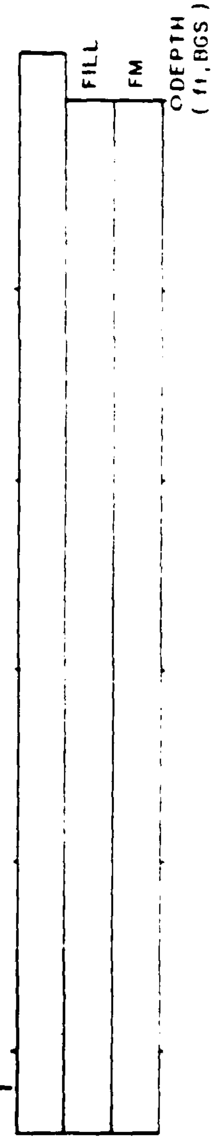
ft. BGS=feet below ground surface

STATIC W.L. 420.7 ft, BGS; 10 Feb 84

DEVELOPMENT Bailed 7.5 hours On 5 Jan 84 Pumped 8 hrs @ 1gpm.

NOT TO SCALE

STICKUP PVC-1.16'



TD CASED 475ft

TD DRILLED 480ft, BGS

WELL CONSTRUCTION SUMMARY

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
P		0	CLAYEY SAND - light brown 5YR 5/5 with	Drilling pad - disturbed and
			gravel (angular) tr. caliche	compacted.
P		2.5	SANDY CLAY - reddish light brown with	
			gravel and lenses of clay with tr. organics	
				To 5 Ft. logged from mud pit
				excavation
C		10	SANDY SILT - reddish light brown poorly	
			sorted with gravel, sand & clays gravel is	
			granitic	
C		20	SANDY CLAY to CLAYEY SAND - moderate yellow	
			brown 10YR 5/4, quartizose sand.	
C		30	SANDY CLAY/SILT - Light brown 5YR 4/5 sand	
			is m-f grained, interbedded with arkosic(?)	
			gravel to coarse sand.	
C		46	SANDY SILT - Moderate yellow brown 10YR 5/3,	
			sand 15%, vf-f grained	
C		58	SANDY CLAY - Moderate brown 5YR 4/5 sand	
			5-10%, f. grained clays are plastic	
				65'-Loosing water-clays
				balling

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 1 of 5
BORING No. DM-01

CESA-DL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		67	SILTY SAND - Moderate brown 5YR 4/4, sand f.-c. grained, with silty clay. Sand fraction granitic and cherty.	
C		80	Gradational change to coarse sand-fine gravel, fine sand and silt & clays to traces	
C		90	Gradational change to SILTY SAND sand averages m. grained, clay to v.f. sand fraction 30-40%.	
C		93	SANDY CLAY - Pale yellow brown 10YR 6/2. Plastic.	
C		96	CLAYEY SAND - Moderate yellow brown 10YR 6/4 with lenses of SANDY CLAY as at 93' and coarse sand to gravel.	
C		123	SILTY SAND - Moderate yellow brown 10YR 5/4, gravelly, sand is well graded, coarse gr. fraction is granitic with chert and tr. micritic limestone.	
		130	Becomes interbedded with silty clays and average grain size to fine gravel-very coarse sand.	
		140	Gradational change to SANDY GRAVEL Quartz 30-40%, felds 10-20%, chert 30-40%, limestone 10%. Well graded to v.f. grained sand.	

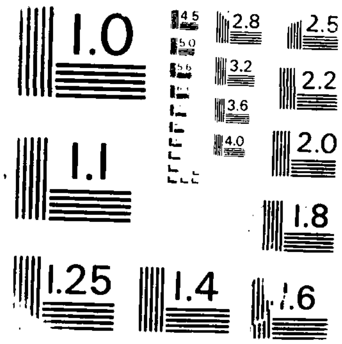
CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. ~~1-220-06-351-33~~

SAI by Culver
SHEET 2 of 5
BORING No. DM-01

CESA-DL-81

FIELD LOG

AD-A227 088 INSTALLATION RESTORATION PROGRAM 3/4
CONFIRMATION/QUANTIFICATION STAGE 1 PHAS (U) SCIENCE
APPLICATIONS INTERNATIONAL CORP ALBUQUERQUE NM
UNCLASSIFIED 07 MAR 85 SAIC-2-827-06-351-33 F/G 24/7 NL


1.0
4.5
5.0
5.6
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
		143	SILTY SAND - average med-grained, m-w graded.	
				160' tr. pummice?
C		173	SANDY CLAY(?) - Yellow gray 5Y 7/2, sand 10%, fine grained.	
C		186	Gradational change to SILTY SAND - dark yellow brown 10YR 4/2, m-w graded, sand fraction is m-c grained, granitic and cherty	
C		200	Sand fraction decreases to m-f grained	
C		215	Sand fraction increases to m-c grained	
C		226	SILTY SAND - 5% c grained sand no color recorded. assume moderate yellow brown 10YR 5/2	partially indurated?
C		250	SILTY SAND - sand fraction is m-f grained with varying ammounts (10%) of coarse sand-gravel	reduce induration?
C		276	SANDY CLAY/SILT - moderate yellow brown 10YR 5/5, sand fraction averages f. grained and is cherty. Interbeds of m-c grained sand 2' thick @ 4' intervals.	
C		290	Gradational change to SILTY SAND pale yellow brown 1-YR 5-6/2. grain size averages m-f sand & ranges from clay to coarse gravel. W/ interbeds of SANDY CLAY/SILT as at (cont.)	

CLIENT Kirtland AFB

LOCATION Albuquerque, NM

PROJECT No. 1-220-06-351-33

SAI by Culver

SHEET 3 of 5

BORING No. DM-01

CESA-DL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		290	(cont.) 276 ft., 20% of 10' section	
C		310	Gradational change: Sandy Clay/Silt inter-beds absent, grain size average to m-c grained, limestone 15-20% of sandy fraction.	
C		320	Grain size average to m-f grained.	
C		338	SANDY CLAY - pale yellow brown 1- YR 6/2, sand fraction f grained	
C		341	SILTY(?)SAND - dark yellow brown 10YR 5/4 with interbeds of silty sand (m-f grained) 6" thick @ 1.5 ft. intervals.	
C		370	Gradational change: sandy interbeds to 35-45% of section and grain size increases to m-c grained	increase induration
C		380	Gradational change=sandy interbeds to 25% of section	
C		386	SILTY(?) SAND - average grain size is m grained, well graded.	
C		389	SANDY SILT - moderate yellow brown 10YR 5/4	
C		391	SILTY SAND - average grain size is m grained well graded	

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 4 of 5
BORING No. DM-01

CESA-OL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		393	SANDY CLAY(?) - moderate yellow brown 10YR 5/4	increase induration
				400 ft - mud sample taken @ 13:51;12/27/83. Sample destroyed in storage by container failure. No analysis forthcomming.
C		410	SANDY SILT - pale yellow brown 10YR 6/2, sand fraction is c-f grained, quartzose, with 10% K-spar. Interbedded with traces of CLAY, pale red 1-YR 6/2	
				40 ft. decrease induration
C		420	Gradational Change of sand fraction to m-f grained.	
C		430	Gradational Change of coarse sand and gravel to 10-15%	
				435 drilling mud thinning
C		460	SANDY SILT with traces of gravel	
C		480	SANDY SILT pale yellow brown 10YR 6/2, sand fraction is c-m grained	
				TD: 480 ft. BGS Cuttings settled to 475 ft. BGS

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-00

SAI by Culver
SHEET 5 of 5
BORING No. DM-01

CESA-DL-81

FIELD LOG

AQUIFER TEST DATA

CLIENT: KAFB/IRB		JOB: 351-33	WELL No. DM-01		SHEET 1 OF 1
DATE	**TIME**	**DEPTH TO WATER, FT.**	**DISCHARGE, GPM or FLOW METER READINGS**	**CONDUCTIVITY or PH**	**REMARKS**
1 Feb84	17:16	422.21	Not Pumping	N/A	
2 Feb84	09:28	422.05	N/A	N/A	Heavy Runway traffic
	09:34	422.05	N/A	N/A	"
	09:44	422.04	N/A	N/A	"
3 Feb84	08:33	422.23	N/A	N/A	"
	08:38	422.18	N/A	N/A	"
	08:43	422.18	N/A	N/A	"
6 Feb 84	09:50	422.76	N/A	N/A	Low Rnwy traffic
	09:55	422.63	N/A	N/A	"
	09:59	422.73	N/A	N/A	"
7 Feb84	08:51	422.62	N/A	N/A	"
	08:56	422.62	N/A	N/A	"
	09:00	422.63	N/A	N/A	"
8 Feb84	08:41	422.65	N/A	N/A	Mod. Rnwy traffic
	08:45	422.65	N/A	N/A	"
	08:50	422.66	N/A	N/A	"
9 Feb84	12:48	422.10	N/A	N/A	"
	12:53	422.10	N/A	N/A	"
	12:58	422.09	N/A	N/A	"
10Feb84	10:44	421.94	N/A	N/A	Light Rnwy Traffic
	10:50	421:91	N/A	N/A	"
	10:55	421.91	N/A	N/A	"
Note:	Measurements are not corrected for stretch				

FORM 206-28

* Measured from M.P. whose elevation is 5319.58 feet, MSL

AQUIFER TEST DATA

CLIENT: KAFB/IRP	JOB: 351-33	WELL No. DM-01	SHEET 1 OF 1

DATE	TIME	DEPTH TO WATER, FT.	DISCHARGE, GPM or FLOW METER READINGS	CONDUCTIVITY or PH	REMARKS
11Jan84					Pump set @ 440 ft.BGS
11Jan84	10:25				Pump On
	10:32			2.3 x 100	
	10:35			4.4 x 100	drilling fluid
	10:42		2.0liters/27sec=1.17GPM		
	11:00			4.4 x 100	
	11:10				discharge muddy-no send
	11:30			3.4 x 100	"
	11:37				discharge clearing
	12:00			3.0 x 100	
	12:30			2.9 x 100	
	13:00			3.0 x 100	discharge clearing more
	13:03		2.0L/27sec		
	13:31			2.9 x 100	
	13:40		2.0L/30sec		
	14:00			2.9 x 100	
	14:02		2.0L/28sec		
	14:30			2.9 x 100	
	14:36				Generator off for maintenance
	15:00			2.9 x 100	
11Jan84	15:05				Gathered DM-01=#1*
					End of Test
			QA #351-33-DM-01-01		

FORM 806-28

*Sample DM-01-01 destroyed during storage - resampled on 23 January 1984.

AQUIFER TEST DATA

CLIENT: KAFB/IRP	JOB: 351-33	WELL No. DM-01	SHEET 1 OF 1

DATE	TIME	DEPTH TO WATER, FT.	DISCHARGE, GPM or FLOW METER READINGS	CONDUCTIVITY or PH	REMARKS
23Jan84				Conductivity not measured	
	13:38				Pump On
	13:42		2.0 Liters/22 sec		
	13:47:30		2 gallons/1 min 55 sec		
	14:06:30		2 gal/1 min 42 sec		
	14:30:00		2 gal/1 min 50 sec		
	15:03:15		2 gal/1 min 52 sec		
	15:31:00		2 gal/1 min 49 sec		
	16:00:00		2 gal/1 min 48 sec		
	16:30:00		2 gal/1 min 55 sec		DM-01-02
23Jan84	16:40:00				Sample Taken;
					End of Test
			QA# 351-33-DM-01-02		

FORM 206-18

SCIENCE APPLICATIONS, INC.
505 Marquette Avenue N.W.
Albuquerque, New Mexico 87102

BORING No. DM-02
DEPTH DRILLED 450 ft, BGS
SCREENED FORMATION(S) QTsf

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33
SURVEY DATA (Coord.) 409389.02 ft E; 1465447.12 ft N
TOP of PIPE ELEV. 5284.27 (ft,MSL) **GROUND ELEV.** 5282.42 (ft, MSL)

DRILLING

DRILLER Rodgers & Co **RIG TYPE** Gardner Denver 1000
START 3 January 1984 **END** 10 January 1984
BIT SCHEDULE 8 3/4" Retipped Soft Formation Tricone Bit. 0-480 ft, BGS.
DRILLING FLUIDS Baroid "Quik Gel"TM bentonite drilling mud.

WATER ENCOUNTERED AT
Not discernable during drilling

CONSTRUCTION

CASING SCHEDULE All casing flush threaded sch 40 PVC. 0-378 ft, solid; 378-428 ft, 0.020 "slot screen; 428-438 ft, solid; threaded end cap.

BACKFILL SCHEDULE 0-367(?)ft, natural material backfill; 367(?)-370 ft, Bentonite pellet seal (20lb) 370-450 10-20 Silica sand (2200lb)

GEOPHYSICAL LOGS
None.

COMMENTS Locking steel cap set in concrete at well head. See Lt. Col. Robinson (1606th ABW/, SGPBE, KAFB)

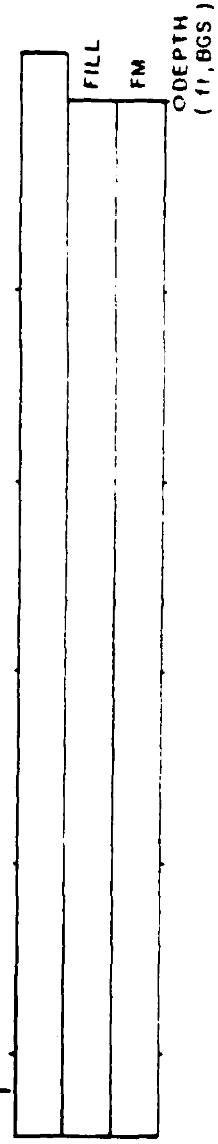
ft, BGS=feet below ground surface

STATIC W.L.
378.5 ft BGS; 10 Feb 84

DEVELOPMENT
Bailed 2.5 hrs. On 13 Jan 84 Pumped 5.0 hrs. @2gpm

NOT TO SCALE

STICKUP
PVC-1.85'



TD CASED 438

TD DRILLED 450 ft, BGS

WELL CONSTRUCTION SUMMARY

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
P		0	SILTY SAND - moderate yellow brown, 10YR 5/4 (dry color), gravel 10%	0-5 ft, logged from mud pit excavation
P		2.0	SANDY SILT - moderate yellow brown 10YR 6/4 (dry color) sand is coarse.	
P		3.0	SILTY SAND - very pale orange. 10YR 8/2 (dry color), sand is coarse	
P		3.2	SANDY SILT - moderate yellow brown 10YR 6/4 (dry color)	
		4.8	SILTY SAND - very pale orange 10YR 8/2	
C		10	SANDY SILT with interbeds of silty sand with gravel moderate yellow brown 10YR 5/4	
C		20	SILTY SAND light brown 5YR 5/6 poorly sorted sand is f to v.c. with gravel.	
C		30	To moderate yellow brown 10YR 5/3	
				41' Cuttings become micaceous
C		43	CLAYEY SILT stringers grade to	
C		47	SANDY SILT light brown 5YR 5/6 with clay, sand is f. grained.	
C		70	Color to moderate yellow brown 10YR 5/4	

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 1 of 4
BORING No. DM-02

CESA-DL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		75	SILTY SAND - moderate yellow brown 10YR	
			5/4, well graded, sand is quartzose	
C		81	SANDY SILT - moderate yellow brown 1-YR 6/4	
			sand is m.-f. grained.	
				98' increase induration
				101' decrease induration
C		119	SAND - moderate yellow brown (?), sand is	
			V.C. to f grained, tr. silt, subarkosic (?),	
			micaceous	
C		140	Gradational Change from 130 ft. to SANDY	hole washing at 140 ft. shows
			SILT with stringers of silty sand moderate	gravel fractions with ~10%
			yellow brown (?)	limestone fragments.
C		150	SANDY SILT - sand fraction to ~10%	
				167' gravel 1 ft thick
C		175	SANDY CLAY - light brown 5YR 5/6 micaceous	
C		180	SANDY SILT - moderate yellow brown 10YR	
			5/4 (?)	
				200'-drilling mud thickening
				in the borehole.
C		210	SANDY CLAY - moderate yellow brown 10YR 5/2	

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 2 of 4
BORING No. DM-02

CESA-DL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		220	Interbedded with m. grained sand. Sand is	
			10% of 10 ft. section.	
C		230	SANDY CLAY dark yellow brown 10YR 4/2 with	darker color due to 1015%
			25-30% interbeds of SILTY SAND dark yellow	micritic limestone and
			brown 10YR 2/2	basalt sand
C		260	SANDY SILT - pale yellow brown 1-YR 6/2	
			with interbeds of SILTY SAND,-well graded,	
			quartzose with 5-10% limestone. Sandy	
			interbeds are ½ to 2 ft thick and 20-30%	
			of section.	
				270 - Gravel-6"thick.
				280-285ft-stringers of
				SILTY CLAY-Light olive gray
				5YR 6/1
C		310	SILTY SAND - dark yellow brown 10YR 4/2	
			well graded from silt to gravel, sandy	
			fraction is quartzose with subordinate	
			limestone.	
C		360	SILTY GRAVEL/SAND dark yellow brown 10YR	
			4/2 with interbeds of SANDY SILT	
		376	SANDY SILT/CLAY - no color recorded	
		378	SILTY GRAVEL as at 360 ft.	

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 3 of 4
BORING No. DM-02

CESA-DL-81

FIELD LOG

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS
C		379	SANDY SILT - moderate yellow brown 10YR	
			5/3, well graded, interbedded with SILTY	
			SAND.	
C		392	SANDY SILT with gravelly interbeds 1 to 2	
			inches thick at 3 inche to 1-foot intervals	
				410 Gravel bedding not
				discernable
C		428	SILTY GRAVEL	
C		430	SILTY SAND - moderate yellow brown 10YR 5/2	
			with interbeds of SANDY SILT/CLAY	
C		450	SILTY SAND - pale yellow brown 10YR 6/2	
			sand is m-f grained.	
				TD=450 ft, BGS;Cuttings
				settled to 438 ft. BGS

CLIENT Kirtland AFB
LOCATION Albuquerque, NM
PROJECT No. 1-220-06-351-33

SAI by Culver
SHEET 4 of 4
BORING No. DM-02

CESA-DL-81

FIELD LOG

AQUIFER TEST DATA

CLIENT: KAFB/IRP	JOB: 351-33	WELL No. DM-02	SHEET 1 OF 1

DATE	TIME	DEPTH TO WATER, FT.	DISCHARGE, GPM or FLOW METER READINGS	CONDUCTIVITY or PH	REMARKS
1 Feb 84	16:55	379.83	N/A	N/A	Calm
2 Feb 84	10:08	379.94	N/A	N/A	"
	10:13	379.93	N/A	N/A	"
	10:19	379.93	N/A	N/A	"
3 Feb 84	09:06	379.78	N/A	N/A	"
	09:11	379.78	N/A	N/A	"
	09:16	379.77	N/A	N/A	'
6 Feb 84	08:52	380.19	N/A	N/A	"
	08:56	380.19	N/A	N/A	"
	09:03	380.19	N/A	N/A	"
7 Feb 84	09:26	380.33	N/A	N/A	"
	09:30	380.32	N/A	N/A	"
	09:35	380.32	N/A	N/A	"
8 Feb 84	09:16	380:39	N/A	N/A	"
	09:24	380.36	N/A	N/A	"
	19:30	380.36	N/A	N/A	"
9 Feb 84	12:19	379.84	N/A	N/A	"
	12:23	379.83	N/A	N/A	"
	12:28	379.83	N/A	N/A	"
10Feb84	10:13	379.62	N/A	N/A	"
	10:18	379.60	N/A	N/A	"
	10:23	379.60	N/A	N/A	"
Note:	All measurements are not corrected for stretch				

FORM 206-28

* Measurements are from M.P. whose elevation is 5284.27 feet, MSL.

AQUIFER TEST DATA

CLIENT: KAFB/IRP	JOB: 351-33	WELL No. DM-02	SHEET 1 OF 2

DATE	TIME	DEPTH TO WATER, FT.	DISCHARGE, GPM or FLOW METER READINGS	CONDUCTIVITY μ mhos	REMARKS
27 Jan84					Pump set at 398 ft. BGS
				Rinse cond: 62	
	09:02:00				Pump On
	09:02:51				Discharge Start
	09:03:00		1 gal 20sec		
	09:07:00				Discharge muddy
	09:08:00				Discharge clear
	09:10:30			570	
	09:12:00				Cloudy discharge
	09:15:15				Very cloudy
	09:23:15			610	
	09:25:45		1 gal 27 sec		Visc. incr, more muddy
	09:29:30		rinse=52 μ mhos	630	Discharge clearing
	09:35:00		1 gal 27 sec		Discharge clearing
	09:37:30			640	
	09:46:00				Cloudy discharge
	09:46:15			660	Extremely Cloudy
	09:48:00				Discharge Clearing
	09:51:30		1 gal 23 sec		
	10:00:00			645	Discharge cloudy but
					clearing
	10:07:00		1 gal 24 sec		
	10:30:00			650	

FORM 206-28

AQUIFER TEST DATA

CLIENT: KAFB/IRP	JOB: 351-33	WELL No. DM-02		SHEET 2 OF 2	
DATE	**TIME**	**DEPTH TO WATER, FT.**	**DISCHARGE, GPM or FLOW METER READINGS**	**CONDUCTIVITY or PH**	**REMARKS**
27Jan84	10:31:15		1 gal 24 sec		
	11:00:00			650	
	11:01:30		1 gal 22 sec		
	11:04:00		rinse: 52 μ mhos		
	11:30:00		1 gal 22 sec	650	
	11:32:00		1 gal 24 sec		
	12:00:00			650	
	12:02:00		1 gal 23 sec		
	12:30:00			650	Trace cloudy
	12:32:00		1 gal 24 sec		
	13:30:00			650	
	13:32:00		1 gal 24 sec		
	13:57:00			650	
	13:59:00		1 gal 24 sec		
	14:02:00				DM-02-02 sample taken
	14:07:00		1 gal 24 sec	650	
27Jan84	14:12:00		rinse 54 μ mhos		End of Test
			QA# 351-33-DM-02-02		

FORM 206-28

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM
Lysimeter No: LF01-01

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
6 Apr 84	14:05	0 in Hg	NS	15 in Hg	Generator on
	14:15	14 in Hg	NS	15 in Hg	--
	14:30	14 in Hg	NS	15 in Hg	--
	14:45	14 in Hg	NS	15 in Hg	--
	15:00	14 in Hg	NS	15 in Hg	--
	15:15	14 in Hg	NS	15 in Hg	--
	15:30	14 in Hg	NS	15 in Hg	--
	15:45	14 in Hg	NS	15 in Hg	--
	16:00	14 in Hg	Dry	15 in Hg	Attempted to lift sample: No recovery
	16:15	0 in Hg	NS	15 in Hg	Generator on
	16:30	14 in Hg	NS	15 in Hg	--
	16:45	14 in Hg	NS	15 in Hg	--
	17:00	14 in Hg	NS	15 in Hg	--
6 Apr 84	17:15	14 in Hg	Dry	15 in Hg	Attempt to Lift Sample: No Recovery

Project No.: 1-220-06-351-33 Page 1 of 1

Note: 1) Sampling effort terminated 6 April 84; 17:15 - no liquid sample
2) Lysimeter was primed with approx 50 ml distilled water prior to each vaccuum application
3) NS = No sample acquisition attempted

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM

Lysimeter No: LF01-02

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
9 Apr 84	09:53	0 in Hg	NS	18 in Hg	Generator on
	09:54	18 in Hg	NS	18 in Hg	--
	10:18	18 in Hg	NS	18 in Hg	--
	10:40	18 in Hg	NS	18 in Hg	--
	11:00	18 in Hg	NS	18 in Hg	--
	11:45	18 in Hg	NS	18 in Hg	--
	12:00	18 in Hg	30ml/no cond	18 in Hg	Attempted to lift sample: 30ml recovery insufficient Vol for cond. meas.
	12:15	0 in Hg	NS	18 in Hg	Generator on
	12:30	18 in Hg	NS	18 in Hg	--
9 Apr 84	13:00	18 in Hg	30ml/142μ mhos*	18 in Hg	Attempted to lift sample: 30ml recovery insufficient for analysis.

Project No.: 1-220-06-351-33 Page ______ of ______

Note: 1) Sampling effort terminated 9 April 84; 13:00 - insufficient liquid sample for analysis.
2) Lysimeter was primed with approx. 50 ml distilled water prior to each vacuum application
3) NS = No sample acquisition attempted.
* = Conductivity measured on composite sample volume

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM

Lysimeter No: LF02-01

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
6 Apr 84	09:50	0 in Hg	NS	14 in Hg	Generator on
	10:00	14 in Hg	NS	14 in Hg	--
	10:15	14 in Hg	NS	14 in Hg	--
	10:30	14 in Hg	NS	14 in Hg	--
	11:00	14 in Hg	NS	14 in Hg	--
	11:30	14 in Hg	NS	14 in Hg	--
	12:00	14 in Hg	50ml/225 μ mhos	14 in Hg	Attempted to lift sample 50ml recovery
	12:15	0 in Hg	NS	14 in Hg	Generator on
	12:30	14 in Hg	NS	14 in Hg	--
	12:45	14 in Hg	NS	14 in Hg	--
	13:00	14 in Hg	NS	14 in Hg	--
6 Apr 84	13:15	14 in Hg	40ml/120 μ mhos	14 in Hg	Attempted to lift sample: 40ml recovery

Project No.: 1-220-06-351-33 Page 1 of 1

Note: 1) Sampling effort was terminated on 6 April 84:13:15 - insufficient liquid sample for analysis
2) Lysimeter was primed with approx. 50 ml distilled water prior to each vacuum application
3) NS = No sample acquisition attempted

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM
Lysimeter No: LF02-02

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
10 Apr 84	14:08	0 in Hg	NS	14 in Hg	Generator on
	14:15	14 in Hg	NS	14 in Hg	--
	14:30	14 in Hg	NS	14 in Hg	--
	15:00	14 in Hg	NS	14 in Hg	--
	15:30	14 in Hg	NS	14 in Hg	--
	16:00	14 in Hg	30ml/no cond.	14 in Hg.	Attempted to lift sample: insufficient vol
	16:08	0 in Hg	NS	14 in Hg	Generator on
	16:32	14 in Hg	NS	14 in Hg	--
	17:00	14 in Hg	NS	14 in Hg	--
	17:30	14 in Hg	10ml/173μ mhos	14 in Hg	Attempted to lift sample: insufficient vol

Project No.: 1-220-06-351-33 Page 1 of ____

Note: 1) Sampling effort terminated 10 April 1984; 17:30 - insufficient liquid volume for analysis.
2) Lysimeter was primed with approx. 50 ml distilled water prior to each vacuum applicaiton.
3) NS = No sample acquisition attempted
* = conductivity measured on composite sample volume

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM
Lysimeter No: LF03-01

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
		NOT TESTED DUE TO BROKEN LYSIMETER			

Project No.: 1-220-06-351-33 Page ______ of ______

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM
Lysimeter No: LF04-02

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
10 Apr 84	09:48	0 in Hg	NS	15 in Hg	Generator on
	10:00	15 in Hg	NS	15 in Hg	--
	10:30	15 in Hg	NS	15 in Hg	--
	11:00	15 in Hg	NS	15 in Hg	--
	11:30	15 in Hg	NS	15 in Hg	--
	12:00	15 in Hg	Dry	15 in Hg	Attempted to lift sample: dry
	12:08	0 in Hg	NS	15 in Hg	Generator on
	12:30	15 in Hg	NS	15 in Hg	--
	13:00	15 in Hg	NS	15 in Hg	--
10 Apr 84	13:30	15 in Hg	20ml/no cond.	15 in Hg	Attempted to lift sample: 20ml insufficient for analysis

Project No.: 1-220-06-351-33 **Page** 1 **of** 1

Note: 1) Sampling efforts terminated 10 April 1984; 13:30 - insufficient liquid sample for anlaysis.
2) Lysimeter was primed with approx 50 ml distilled water prior to each vacuum application
3) NS = No sample acquisition attempted

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM
Lysimeter No: RB11-01

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS
3 Apr 84	14:47				Test Aborted-Damaged vacuum pump
4 Apr 84	13:53	0 in Hg	NS	10 in Hg	Generator on
	14:00	9 in Hg	NS	10 in Hg	--
	14:28	9 in Hg	NS	10 in Hg	--
	14:58	9 in Hg	NS	10 in Hg	--
	15:00	9 in Hg	Dry	10 in Hg	Attempted to lift sample: dry
	15:10	0 in Hg	NS	10 in Hg	--
	15:27	9 in Hg	NS	10 in Hg	--
	16:00	9 in Hg	NS	10 in Hg	--
4 Apr 84	16:30	9 in Hg	Dry	10 in Hg	Attempted to lift sample: dry

Project No.: 1-220-06-351-33 Page 1 of 1

Note:
1) Sampling efforts terminated 4 Arpil 1984; 16:30 - no liquid sample.
2) Lysimeter was primed with approx 50 ml distilled water prior to each vacuum application.
3) NS = No samole acquisition attempted.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 1606TH AIR BASE WING (MAC)
KIRTLAND AIR FORCE BASE, NEW MEXICO 87117

RECEIVED
FEB 21 1984
SAI/ABQ

REPLY TO ATTN OF: SGPBR (844-0598)

15 Feb 84

SUBJECT: Soil Monitoring

TO: Science Applications, Inc.
505 Marquette Ave., N.W.
Albuquerque, NM 87102

1. On 6 Feb 84, the Radiological Health Section was called upon to assist in the drilling of burial site RB-11. This was a follow-up drilling operation which was done at a 50^{o} angle to the trench.

2. Equipment Used. Technical Associates, Model TBM-3, Serial No. 041254, calibrated 18 Jan 84 with a calibration due date of 18 Jul 84.

3. Soil samples were drawn from 13 feet, 23 feet, 33 feet, 43 feet and 53 feet. All readings were found to be from .02 mR/hr to .04 mR/hr, which is normal background for the area.

4. If you have any questions concerning this survey, feel free to contact this office at 844-0598 and reference RSS #84-047.

Melvin C. Jones
MELVIN C. JONES, TSgt, USAF
NCOIC, Radiological Health
USAF Hospital Kirtland

DEPARTMENT OF THE AIR FORCE
USAF HOSPITAL KIRTLAND (MAC)
KIRTLAND AIR FORCE BASE, NEW MEXICO 87117

SGPBR (844-0598) 15 July 1983

Mr. Don Silva
Science Applications, Inc.
505 Marquette Ave., NW
Albuquerque, NM 87102

Dear Mr. Silva:

We surveyed the core samples removed from radioactive burial site No. 11 on 6 Jun 83. The instrument we used was a Ludlum Model 19 Micro R Meter, Serial No. 21540, calibrated 2 Feb 83. The Ludlum Micro R instrument detects low energy X and gamma radiation. Normal background readings are 20 μR/hr or .02 mR/hr.

We took readings from the core samples at depths of 5, 10, 15, 25, 30, 40, and 50 feet. We monitored the samples below 50 feet as one unit. The readings at all depths did not exceed the normal background reading.

If you have any questions regarding this survey, please call us at 844-0598.

Thank you,

C David Lovell

C. DAVID LOVELL, 2Lt, USAF, BSC
OIC, Radiological Health/RPO
USAF Hospital Kirtland

Appendix F

Sampling Procedures

SAMPLING PROCEDURES

for

Fire Training Area Investigation

Kirtland AFB, N. M.

2 November 1983

Soil Sampling Procedures
Fire Training Area (FTA)
Kirtland AFB, N. M.

1. Retrieve soil samples. Samples from fresh material approximately 1.0 ft below lead edge of auger flight.

2. Starting with the bottom-most materials, empty sampler into sample container. The sample container will be a common 1/2 pint, screw cap mason jar. The mason jar will be rinsed with distilled water and dried in the lab. A minimum of 200 ml. of virgin sample will be gathered.

3. The sample container will be sealed with 4 1/2 inch wide Teflon tape between the glass container (and sample) and metal screw cap.

4. Sample containers will be labled (see example no. 1). In addition sample designations will be placed on the top of the sample container and on a paper slip which will be placed between the Teflon tape and the metal lid.

5. The numbering system for individual samples shall be in the following format: FTA-01-XX. FTA indicates Fire Training Area, 01 indicates the borehole number and XX will indicate sample depth in feet below ground surface and be to the nearest whole foot.

6. These soil samples will be analysed for <u>grease and oil and TOX</u> (Total Organic Halogens) <u>only</u>.

7. The fully labled sample will be immediately placed on ice in an insulated shipping container. The shipping container will be a metal or plastic Coleman-type ice chest.

8. For each shipping container there will be a chain of custody form (see example no. 2). This form will be completed with a carbon copy duplicate. The original will be shipped with the container and the carbon retained at SAI/Albuquerque for confirmation purposes.

9. At the end of the field day all samples will be shipped via overnight delivery service to the JRB lab in La Jolla, CA. All pertinent documentation will be retained at SAI/Albuquerque.

SAMPLE CONTAINER LABEL

SAI/JRB Contract No.: 351-33 Bottle Number 1

Sample No.: FTA-01-05

Sample Date: 11/03/83 Sample Time: 11:00

Sample Location: Kirtland AFB, N.M.

ANALYSIS ☐ Volatiles ☐ Semi-Volatiles ☐ Pesticides ☐ Metals

☐ Inorganics Other TOX, Oil & Grease

Preservation: Ice only Collector: Culver

Remarks: Sample container rinsed with distilled water.

Chain of Custody No.: 351-33-FTA-01

Example Form No. 1

JRB: 2-812-06-351

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: PAGE 1 OF 7

CHAIN OF CUSTODY # : 351-33-FTA-(1-4) SAI: 1-220-06-351-33

COLLECTION LOCATION: Kirtland AFB, N.M. SAMPLERS: Culver (SAI)

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS ANALYSES
FTA-01-XX	11/3/83	11:02	Soil	1	Ice only	TOX, Oil & Grease
FTA-01-YY	11/3/83	11:10	Soil	1	Ice ONLY	TOX, Oil & Grease
FTA-01-ZZ	11/03/83	11:18	Soil	1	Ice only	TOX, Oil & Grease
FTA-02-XX	11/03/83	11:41	Soil	1	ICE ONLY	TOX, Oil & Grease
FTA-02-YY	11/03/83	11:48	Soil	1	ICE ONLY	TOX, Oil & Grease

RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
CLAY N. CULVER (SAI) X	11/03/83 / 16:30 Ship samples to lab.	PRINT: X
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:

Example Form No. 2

FOX

DRILLING PROCEDURES FOR COLLECTION OF SOIL SAMPLES AT THE FIRE TRAINING AREA, KAFB

Drilling will be conducted utilizing a CME-45 truck mounted drill rig and 6-5/8-inch O.D. hollowstem power auger. The rig and drilling equipment will be steam cleaned at the KAFB Equipment Shop and witnessed by a shop employee. The witnessing will be completed by the appropriate signatures presented on the attached form.

Drilling on the 9 hole grid pattern in the suspected contaminated area will begin after the baseline test hole is completed north of the suspected contamination area. Steam cleaned auger will be used on each hole to prevent cross-contamination. No oil or solvents will be used on the rig or equipment during drilling. Undisturbed samples will be collected at the surface and at 5 feet and 10 feet. If disturbed soil or suspected contaminated soil is encountered at 10 feet, the holes will be advanced, within a reasonable distance (maximum of 20 feet), to penetrate uncontaminated natural soil.

After completion of the test holes, the borings will be backfilled with cuttings to within 1 foot of the ground surface where bentonite will be mixed with cuttings to seal the surface of the hole. Where the asphalt area is penetrated by a boring, abandonment of the hole will include cementing the hole from 2 feet below ground surface to within 6 inches of grade with concrete. The remaining 6 inches will be filled with asphalt cold patch.

FOX

SAMPLER, LINER, AND GLASS BOTTLE CLEANING

The sampler to be utilized is a modified split California sampler. The sampler is 2-1/2 inches O.D. and is assembled with four 2-inch O.D. 4-inch long brass liners on the inside. The soil samples are collected from the brass liners which are removed once the sampler is disassembled.

The brass liners were previously used on sites where no known contamination existed. Prior to use, the liners were thoroughly washed with hot clean water (Albuquerque tap water), the clean liners were then rinsed with distilled water, air dried and boxed on November 2, 1983. The sampler was also cleaned as discussed above.

The glass containers for the samples were purchased, rinsed with distilled water, dried with clean disposable paper towels, capped and boxed on November 2, 1983.

FOX

Job No.: 0111210 DATE: ____________________

Job Name: KAFB/IRP

PROCEDURE: Steam cleaning of drilling equipment being used at the Fire Training Area for soil sample collection (KAFB)

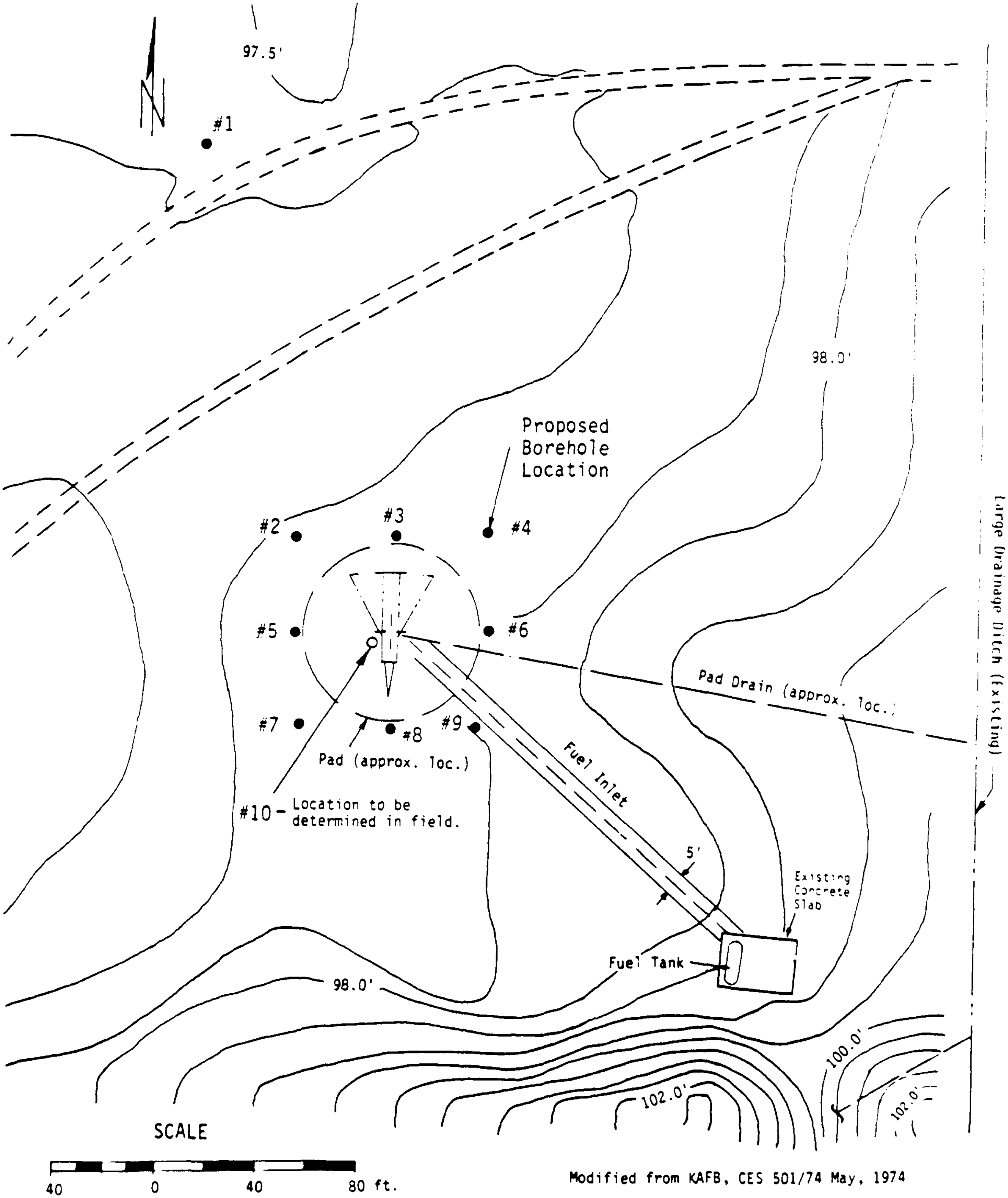
LOCATION: KAFB Equipment Shop Steam Cleaner

SHOP EMPLOYEE WITNESS: ____

EMPLOYEE POSITION: ____

FOX EMPLOYEE: ____

Proposed Drilling Plan
Fire Training Area
Kirtland AFB IRP



Modified from KAFB, CES 501/74 May, 1974

Contour Interval: 0.5 ft.

2 Nov. 83

DRILLING AND SAMPLING PROCEDURES

FOR THE

PROPOSED DEDICATED MONITOR WELLS

AT

KIRTLAND AFB, NM

15 December 1983

I. PREFACE.

The current contract (Number 33615-80-D-4002-003302) authorizes: 1) the construction of two (2) deep, dedicated monitor wells on Kirtland AFB lands and; 2) the collection of one (1) water sample from each well. The purpose of these wells is to monitor the quality of the groundwater down-gradient from Landfills #1 and #2.

F.M. Fox and Associates has contracted Rodgers and Company to perform the drilling, casing, back filling and initial development of these deep wells. Science Applications International (SAI) shall provide an on-site geologist for all phases of well construction and sampling. In addition, SAI will document all particulars regarding strata encountered, fluid and completion schedules, water sampling and quality assurance. A sample well history form is included as an attachment to this document and will serve to document these items.

II. BOREHOLE LOCATIONS.

On 5 December 1983 KAFB, F.M. Fox and SAI personnel flagged the proposed borehole locations (see attached). Items flagged at each site include a pad area and two mud pits. Kirtland AFB Civil Engineering has been contacted with the specific earth-moving needs for this project.

III. DRILLING PROCEDURES.

A) The driller will be contacted prior to field work to arrange for necessary base passes.

B) The drill rig and drill string will be steam-cleaned at KAFB facilities before the first hole is drilled, between holes and after the last hole is completed. Documentation of each cleaning event shall be provided (See Attachment).

C) A 9-inch O.D. borehole shall be drilled using bentonite and water drilling fluids and normal rotary methods. Grab samples of the well cuttings from five (5) to ten (10) foot intervals will be gathered and described by an on-site geologist provided by SAI.

These descriptions will be recorded on SAI drilling logs (See Attachment). No testing is planned for these grab samples.

It is estimated that at well DM-01 (Landfill #1) the total depth will be 475-480 foot below ground surface and that total depth for DM-02 (Landfill #2) will be 435-445 foot below ground surface.

D) Upon completion of each borehole a casing string shall be installed. The casing will be 5.5 inch OD, flush threaded SCH 80 PVC. The casing shall be assembled as follows: from the bottom of the hole,

a) end cap or plug
b) 10 feet of blank casing
c) 50 feet of .035 inch slot screen
d) blank casing to surface
(415 feet for DM 01 and 375 feet for DM-02)

The casing schedule for each well shall be documented on a Well Construction Summary Sheet (Attached).

E) The boreholes will then be backfilled (outside the casing) with 20-30 gradation Fountain Silica (bagged and washed) sand to the top of the screened interval. A two (2) foot thick bentonite seal will be placed over the sand pack. The remainder of the annular space will be backfilled with caved material and/or cuttings.

A locking steel cap shall be installed over the wellhead. The backfill schedule for each well shall be documented on the Well Construction Summary Sheet by the geologist.

F) Each borehole will then be developed by the driller via air-lift or other mechanical methods. This stage of the development shall be considered complete when the suspended solids have been flushed and clean water is being produced (See Section IV.A).

G) At this point the drill rig will be authorized to proceed to the steam cleaning area. In the event shutdown occurs after normal base hours, the drill rig shall be left onsite and prior to additional drilling or exiting Kirtland AFB lands.

H) It is anticipated that water sampling shall occur several days after completion. Keys for the locked caps shall be placed in the custody of Lt. Colonel Robinson who will monitor all subsequent activities at either well.

IV. WATER SAMPLING PROCEDURES.

A) Well Development:

1) Well development is scheduled for two stages. The first stage will involve air lift and/or swabbing of the well. The second stage will require sustained pumping of the well with a submersible pump.

2) The method of first stage development will be determined in the field by on-site SAI personnel in conjunction with the well driller. The method will be either by air lift (pumping compressed air to the bottom of the wellbore via the drill stem) and/or swabbing (physically lifting or bailing the water from the wellbore with a wire line cable). In no case will chemical or other possible contaminent sources be introduced to the well. The purpose of the initial development is to remove fine or suspended solids from the wellbore (drilling mud and fines

surrounding the well screen and gravel pack). Conductivity measurements and visual examination of the produced water will be used to determine satisfactory completion of the initial development stage - i.e., when suspended solids production has reached a minimum.

3) The second stage of well development will include production of ground water via a portable submersible pump, discharge pipe and generator. The submersible pump, discharge tubing and electrical cable will be steam cleaned prior to placement in the wellbore. The submersible pump discharge pipe and electrical cable will be lowered to a depth corresponding to the bottom of the screened interval in each well and pumped at maximum capacity for a period of eight hours or until one-half hour interval conductivity measurements show less than 10% deviation over three consecutive measurements - whichever occurs first. At that point a one-liter sample will be collected as described in the following section.

B) Sample Acquisition:

1) Pre-rinse a one-liter glass sample container and cap with discharged waters.

2) Fill the sample container so as to remove all the contained air and cap immediately.

3) The sample container shall be dried and the cap sealed with adhesive tape. A completed adhesive label (See Attachment) will be affixed to the bottle. In addition, the sample number and date will be inscribed with indelible ink on the bottle itself.

4) At this point the pump may be turned off and pump pulling procedures initiated.

5) This water sample shall be analysed for TOX, TOC and Nitrate only (See Attachment).

6) The labeled sample container will be placed in an ice-filled shipping contained and the appropriate chain of custody documentation (See Attachment) attached.

7) At this point the sample will either be signed over to base personnel (at comissary freezer) for overnight storage or be shipped via the next available overnight package service. (Deadlines: 4:00 p.m. for next day delivery by Emery Worldwide express services)

DATE	ACTION	COMMENTS

CLIENT ______________________
LOCATION ______________________
PROJECT NO. ______________________

SAND INTRVL. ______________
FORMATION ______________
BORING NO. ______________

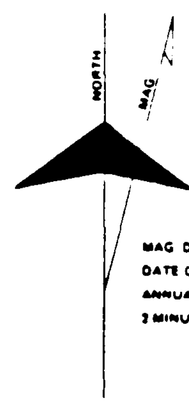
WELL HISTORY

ATTACHMENTS

LEGEND

●	EXPLORATION TEST HOLE (Completed June 1983)
———	SEISMIC LINE LOCATION
▬ ▪ ▬	LANDFILL BOUNDARY (Tentative Location June 1983)
■	PROPOSED DEDICATED MONITOR WELL
◆	PROPOSED LYSIMETER and BEARING
—— · ——	LANDFILL BOUNDARY FROM PREVIOUS INVESTIGATIONS
▲	SANITARY SEWER LINE BOREHOLE (Molzen-Corbin & Assoc.,1977)

BUILDING PERMANENT
BUILDING SEMI-PERMANENT
BUILDING TEMPORARY
ROADS AND PARKING
ROAD UNIMPROVED
FENCE
RAILROAD
DRAINAGE CHANNEL
BRIDGE
RESERVATION BOUNDARY
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR

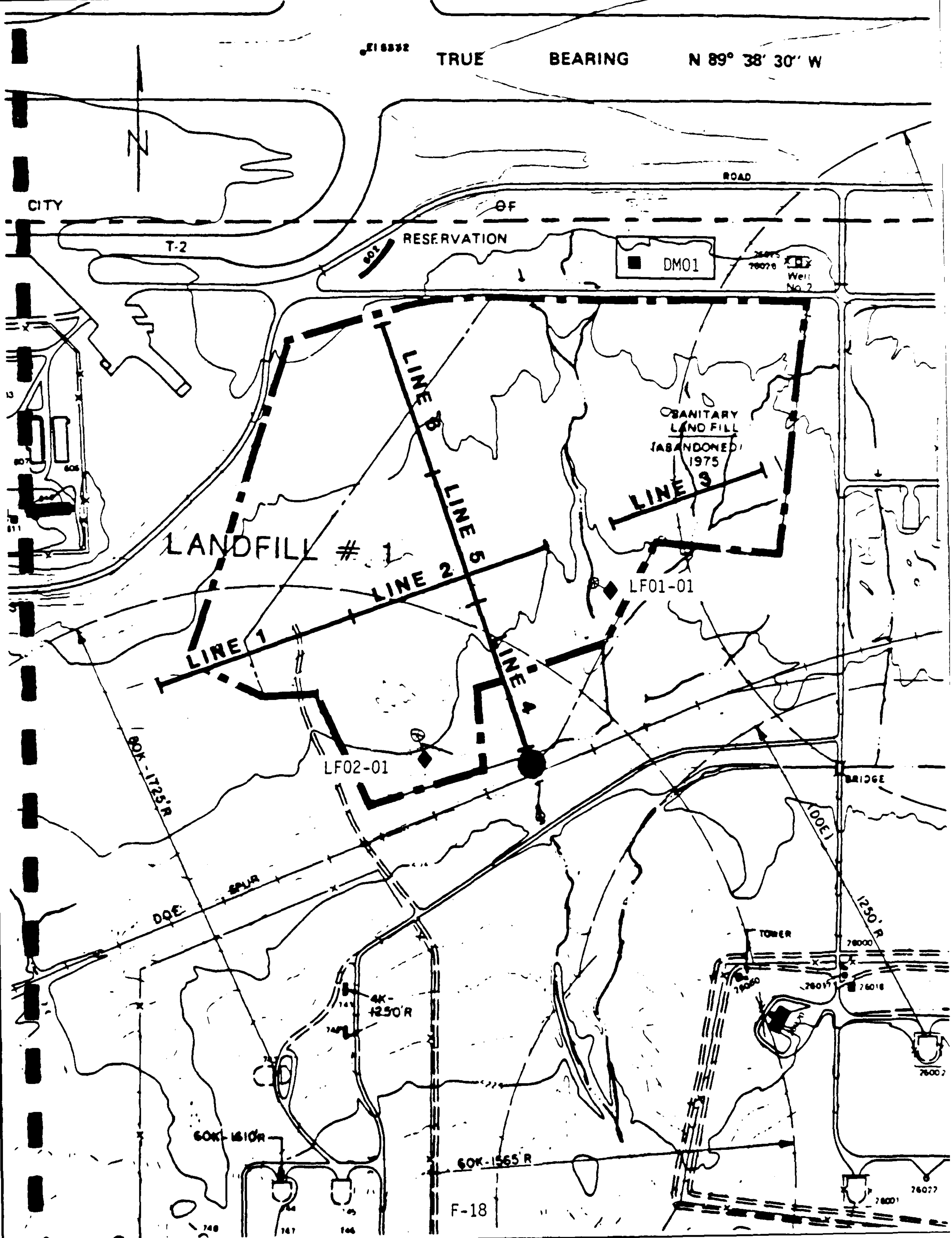


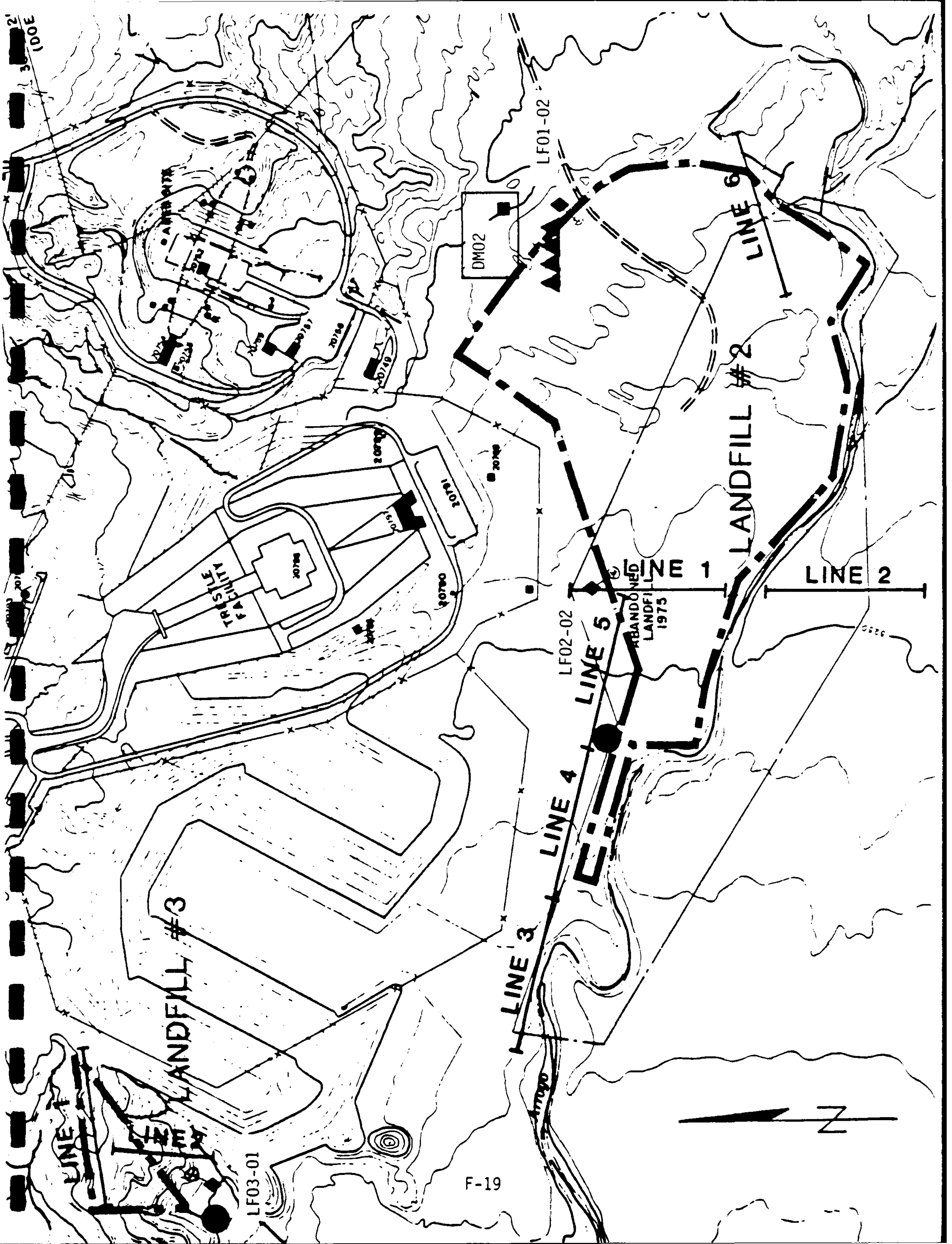
MAG DEC - 12°[illegible]E
DATE OF DATA 1971
ANNUAL CHANGE
2 MINUTES WESTERLY

SCALE IN FEET

CONTOUR INTERVAL 5 AND 10 FEET

AIRFIELD ELEVATION 5352' R/W 26


TRUE BEARING N 89° 38' 30" W
N
ROAD
CITY
OF
RESERVATION
T-2
DM01
Well No 2
SANITARY LAND FILL (ABANDONED) 1975
LINE 3
LINE 6
LINE 5
LINE 4
LINE 2
LINE 1
LANDFILL # 1
LF01-01
LF02-01
60K-1725'R
BRIDGE
(DOE)
DOE SPUR
1250'R
TOWER
4K-1250'R
60K-1610'R
60K-1565'R


LANDFILL #2
LANDFILL #3
ABANDONED LANDFILL 1975
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
LF01-02
LF02-02
LF03-01
DM02
TRESTLE FACILITY

Job No.: 1-220-06-351-33 Date:__________________

Job Name: Kirtland AFB/IRP

PROCEDURE: Steam cleaning of drilling equipment being used to drill dedicated monitoring wells at Kirtland AFB.

LOCATION: Kirtland AFB Equipment Shop Steam Cleaner

SHOP EMPLOYEE WITNESS:________________________________

EMPLOYEE POSITION: ________________________________

DRILLER: ________________________________

SAI EMPLOYEE: ________________________________

(Modified from FM Fox, 11/83)

SCIENCE APPLICATIONS, INC.
505 Marquette Avenue, N.W., Albuquerque, New Mexico 87102
505 / 247-8787

SCIENCE APPLICATIONS, INC.
505 Marquette Avenue N.W.
Albuquerque, New Mexico 87102

BORING No. ____________

DEPTH DRILLED ____________

SCREENED FORMATION (S) ____________

CLIENT ____________

LOCATION ____________

PROJECT No. ____________

SURVEY DATA (Coord) ____________

TOP of PIPE ELEV. ________ GROUND ELEV. ________

DRILLING

DRILLER ________ RIG TYPE ________

START ________ END ________

BIT SCHEDULE ____________

DRILLING FLUIDS ____________

WATER ENCOUNTERED AT ____________

CONSTRUCTION

CASING SCHEDULE ____________

BACKFILL SCHEDULE ____________

GEOPHYSICAL LOGS ____________

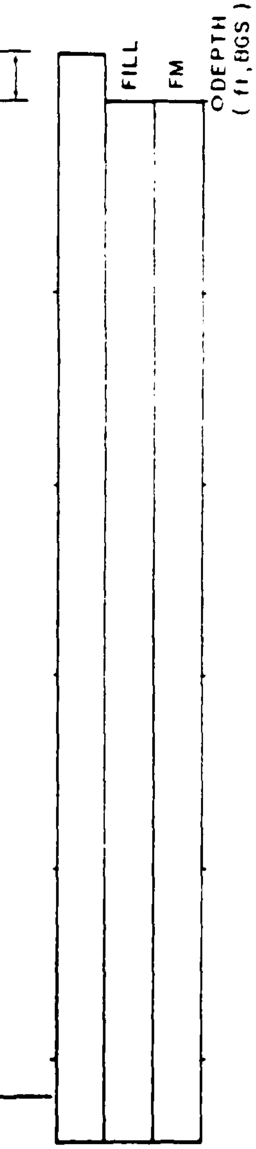
COMMENTS ____________

STATIC W.L. ____________

DEVELOPMENT ____________

NOT TO SCALE

STICKUP ____



TD CASED ____

TD DRILLED ____

CESA-OL-81

WELL CONSTRUCTION SUMMARY

SAMPLE TYPE	SYMBOL	DEPTH	DESCRIPTION	COMMENTS

CLIENT ____________________

LOCATION ____________________

PROJECT No. ____________________

SAI by ____________________

SHEET ______ of ______

BORING No. ____________________

CESA-DL-81

FIELD LOG

AQUIFER TEST DATA

CLIENT:	JOB:	WELL No.	SHEET OF

DATE	TIME	DEPTH TO WATER, FT.	DISCHARGE, GPM or FLOW METER READINGS	CONDUCTIVITY or PH	REMARKS

FORM 206-29

SAI/JRB Contract No.: 351-33 Bottle Number 1

Sample No.: DM-01-01

Sample Date: 04 JAN 84 Sample Time: 14:08

Sample Location: Kirtland AFB, NM

ANALYSIS: ☐ Volatiles ☐ Semi-Volatiles ☐ Pesticides ☐ Metals

☐ Inorganics Other TOC TOX NO_3

Preservation: Ice Only Collector: Culver

Remarks:

Pump On For 4.0 hrs.

Chain of Custody No.: 351-33-DM-01-01

PROJECT NAME: Kirtland AFB, IRP PROJECT NUMBER: 1-220-U-351-33 PAGE 1 OF 1

COLLECTION LOCATION: Kirtland AFB, NM SAMPLERS: Tanner/FOX & Culver/SAI

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
DM01	04/01/84	14:08	WATER	1	Ice Only	TOX, TOC, NO_3

CHAIN OF CUSTODY NO.: 351-33-DM01-01

RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
X	DATE/TIME: 04/01/84; 15:00 REASON: Shipment to Lab	X
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:

FOX

FOX & ASSOCIATES OF NEW MEXICO, INC.

CONSULTING ENGINEERS AND GEOLOGISTS

ALBUQUERQUE OFFICE 3412 BRYN MAWR DRIVE, NE
ALBUQUERQUE, NEW MEXICO 87107
(505) 884-0900

RECEIVED

DEC 12 1983

SAI/ABQ

December 8, 1983

Science Applications, Inc.
505 Marquette NW, Suite 1200
Albuquerque, New Mexico 87102

Attention: Mr. Donald Silva, P. E.

Subject: Scope of Work Associated with Construction and Sampling of Two Deep Groundwater Monitor Wells to be installed in Conjunction with Phase II of the Kirtland Air Force Base IRP Program

Gentlemen:

This letter was prepared to clarify the scope of work and responsibilities of the various parties involved with the construction and sampling of two groundwater monitor wells. The wells are being installed in conjunction with Phase II of the Kirtland Air Force Base IRP Program.

The wells will be drilled by Rodgers and Company under a contract with Fox & Associates of New Mexico, Inc. To prevent "extra" charges from Rodgers and Company it is particularly important to minimize drill rig standby time and changes in the stated scope-of-work. The following sections present a detailed scope-of-work for well installation, development, and sampling.

FOX

CONSTRUCTION OF DEEP GROUNDWATER MONITORING WELL LOCATED NORTH OF LANDFILL NO. 1

- o Steam clean rig prior to drilling at KAFB facilities
- o Drill a 475 to 480 feet deep, 9-inch outside diameter boring using bentonite drilling fluid and normal rotary methods with earthen mud pits and drill pad constructed by Kirtland Air Force Base personnel
- o Install 5.5-inch outside diameter, schedule 80, flush threaded PVC screen and blank casing. The casing string will consist of 415 feet of blank casing, 50 feet of .035-inch slot size screened casing and 10 feet of blank casing with a plug or cap on the bottom.
- o Install 20-30 gradation Fountain Silica sand to the top of the screened interval*
- o Install a 2-foot bentonite seal over the gravel pack*. The remainder of the hole will be allowed to cave or will be backfilled as required
- o Develop well by air lifting or other method (to be decided by the driller) without using chemicals
- o Within 5 to 10 feet of ground surface, install a concrete seal and install a steel locking cap over the well casing

*The above levels will be checked with a steel probe from the surface to insure sand and bentonite seal locations.

FOX

CONSTRUCTION OF DEEP GROUNDWATER MONITORING WELL LOCATED
NORTH OF LANDFILL NO. 2

- o Steam clean rig prior to drilling at KAFB facilities
- o Drill a 435 to 445 feet deep, 9-inch diameter boring using bentonite drilling fluid and normal rotary methods with earthen mud pits and drill pad constructed by Kirtland Air Force Base personnel
- o Install 5.5-inch outside diameter, schedule 80, flush threaded PVC screen and blank casing. The casing string will consist of 375 feet of blank casing, 50 feet of .035-inch slot size screened casing and 10 feet of blank casing with a plug or cap on the bottom
- o Install 20-30 gradation Fountain Silica sand to the top of the screened interval*
- o Install a 2 foot bentonite seal over the gravel pack*. The remainder of the hole will be allowed to cave or will be backfilled as required.
- o Develop the well by air lifting or other method (to be decided by the driller) without using chemicals
- o Within 5 to 10 feet of ground surface, install a concrete seal and install a steel locking cap over the well casing
- o Steam clean rig prior to leaving base

*The above levels will be checked with a steel probe from the surface to insure gravel pack and bentonite seal locations.

NOTE: The installation of the steel locking caps and the grouting in place will be performed by Fox & Associates of New Mexico, Inc. personnel after the wells are complete.

FOX

This completes the subcontract work for this task. The remaining work within this task will be performed by Fox & Associates of New Mexico, Inc. personnel and Fox Drilling.

INSTALLATION OF SAMPLING PUMP IN THE DEEP GROUNDWATER MONITORING WELL LOCATED NORTH OF LANDFILL NO. 1

- Install a one-horse power sampling pump in the well to a depth of approximately 440 feet
- Connect the pump to the surface with 1-inch galvanized pipe and No. 10/3 conductor submersible wire
- Install a sanitary well seal
- Pump the well for 8 hours, discharging the water as appropriate and using a 5000 watt generator as a power source. A full-time crew will not be on the site during this entire phase.
- After sample collection by Science Applications, Inc., the pump, pipe and wire will be pulled from the well and the steel locking cap will be replaced.

INSTALLATION OF SAMPLING PUMP IN THE DEEP GROUNDWATER MONITORING WELL LOCATED NORTH OF LANDFILL NO. 2

- Install a one-horse power sampling pump in the well to a depth of approximately 400 feet
- Connect the pump to the surface with a 1-inch diameter galvanized pipe and No. 10/3 conductor submersible wire
- Install a sanitary well seal

FOX

- Pump the well for 8 hours, discharging the water as appropriate and using a 5000 watt generator as a power source. A full-time crew will not be available on the site during this entire phase.
- After sample collection by Science Applications, Inc., the pipe and wire will be pulled and the steel locking cap will be replaced

It is our understanding based upon requirements of this task that Fox & Associates of New Mexico, Inc. personnel will not be on site during well construction and that Science Applications, Inc. personnel will supervise these activities.

It has also been assumed that Science Applications, Inc. or Kirtland Air Force Base personnel will acquire additional permits beyond the drilling permit, construct the drilling pads, excavate the drilling pits, provide for discharge sites of the pumped water and obtain permission to steam clean the drill rig prior to drilling, between wells, and upon completion of drilling at Kirtland Air Force Base's steam cleaning facility. If necessary, Air Force Base personnel will need to restore the drill pads and mud pits upon completion of drilling to the desired condition.

If you have any questions or require further information please do not hesitate to contact us.

Fox & Associates of New Mexico, Inc.	Reviewed by:
Steve Brewer	Martin D. Vinyard
Steven Brewer Staff Geologist	Martin D. Vinyard, P. E. Geotechnical Section Head

Copies: Mr. Clay Culver, Science Applications, Inc.
Mr. Stuart Faith, Science Applications, Inc.

SAMPLING PROCEDURES

for

LYSIMETER INSTALLATIONS

at

Kirtland AFB, N.M.

Phase II-B

INSTALLATION RESTORATION PROGRAM

by

Science Applications International

January, 1984

Sampling Procedures

for

Lysimeters Installations

at

Kirtland AFB, N.M.

I. Preface

The current working contract for this project (33615-80-D-4002-003302) authorizes one (1) suite of analyses (Attachment 1) per lysimeter site. Although lysimeters represent the best available technology for sampling the soil moisture conditions at Kirtland AFB, there exists the possibility that at least some of the proposed seven (7) lysimeter assemblies will not yield quantities of liquid (soil moisture) that are sufficient for chemical analyses. In order to provide the initial verification of potential contaminant presence, which is required under this contract, a two part sampling approach has been proposed for this project. The first part will require the acquisition and archiving of soil samples from the lysimeter borings at the Kirtland AFB landfill locations. The second part will require the monitoring of the installed lysimeters for vacuum decay rate, soil moisture production volume and conductivity of produced soil moisture to verify the presence of enough soil moisture adequate for chemical analyses. If at the end of a four to six week period, the lysimeters have not yielded sufficient moisture for chemical analyses, a previously archived and preserved soil sample ,which is representative of the lysimeter production zone, will be submitted for chemical analyses by water extraction.

II. Procedures

A. Lysimeter Boring - Soil Sample Archiving

(1) A split spoon sampler will be advanced for one (1) foot at the bottom of each five (5) foot section of auger flight. The sampler will be raised to the surface and the soil sample retreived.

(2) Starting with the bottom-most materials in the split spoon sampler, the soil sample will be emptied into the sample container. The sample container will be a common 1/2 or 1 pint, screw-cap mason jar. The mason jar will be rinsed with distilled water and dried in the lab prior to sampling. A minimum of 200 ml. of "undisturbed" sample will be gathered.

(3) The sample container will be sealed with 4 inch wide Teflon tape between the glass container (and sample) and the metal screw-cap.

(4) Sample containers will be labelled (see Attachment 2). In addition, sample identification will be indelibly marked on the top of the metal screw-cap and on a piece of paper placed inside the jar between the Teflon tape and the metal screw-cap.

(5) The sample numbering scheme for individual samples will be in the following format:

LF01-01-XX

where: LF01 - denotes the landfill sampled
-01 - denotes the borehole number
and -XX - denotes sample depth in feet below ground surface.

(6) The fully labelled sample will immediately be placed on ice in an insulated shipping container. The metal or plastic shipping container will be a Coleman-type ice chest.

For each shipping container there will be a chain-of-custody form (Attachment 2). This form will be completed with a carbon copy duplicate. The original will be shipped with the container and the carbon retained at SAI/Albuquerque for confirmation purposes.

(7) It is estimated that at least four soils samples from each lysimeter boring will be archived. At this juncture it is not known whether the soil samples will be shipped to the La Jolla, Ca. laboratory for archiving or if they will be retained at Kirtland AFB prior to shipment. Chain-of-custody forms will be noted appropriately as to archiving and shipping.

B. Lysimeter Laboratory Testing

Upon receipt of the vacuum lysimeters from the manufacturer, the lysimeter assembly will be inspected and tested according to the following procedures:

(1) Each of the seven lysimeters will be submerged in distilled water and pressurized to approximately 30 psi via the vacuum/pressure line to verify the pressure integrity of the assemby. If gas escape is noted only through the porous intake cup, then it will be assumed that the lysimeter assembly is in proper working order and ready for installation. The lysimeters will be dried and repackaged in their shipping bags. Argon gas will be used for the pressure test.

(2) SAI has been informed by FM Fox and Associates that the all Teflon lysimeters (including the porous intake cup) have been cleaned by the manufacturer prior to assembly, packaging and shipment. The cleaning involves washing all parts in mild detergent followed by several rinses with distilled water. Such cleaning by the manufacturer obviates the need for cleaning the lysimeters in reagent grade hydrochloric acid as this step anticipated that the porous cup would be made from a ceramic material which can absorb detectable quantities of trace elements. The documentation for the factory cleaning will be supplied in the draft final report.

C. Lysimeter Installation

(1) The location for installation of the seven vacuum lysimeter assemblies is shown on the accompanying map enlargements (see Attachment 4).

(2) The lysimeter borings will be completed with an auger drilling rig from FM Fox and Associates. The borings will be completed at an angle of approximately 45 degrees from vertical, to a depth of approximately 53 feet (75 feet boring length) in the azimuth direction indicated on the maps.

(3) Soil sampling and archiving will be as described in Section II-A above.

(4) The auger flights will be steam cleaned prior to and in-between each lysimeter boring and signed off on a form shown as Attachment 5 to this document.

(5) Upon reaching the soil horizon which appears to have the most favorable location for recovering soil moisture samples (based on field examination of soil sample grain size and moisture content), the lysimeters will be installed as described in the following enumerated items.

(6) The lysimeter assembly and appurtenant shroud and sample tubing will be lowered into the boring inside of the hollow-stem auger. Attachments 6 and 7 show the details of the lysimeter assembly and the completed lysimeter sampling assembly, respectively.

(7) After the lysimeter and tubing have been lowered to the target depth, a clean silica sand backfill will be slurried around the porous Teflon intake cup to a sufficient depth to ensure adequate soil and capillary connection to the adjacent native soil. The reagent grade silica sand will be slurried with distilled water via a small diameter (tremmy) pipe, which is inserted to the lysimeter through the hollow-stem auger. The hollow-stem auger will be withdrawn slowly from the boring as the silica sand backfill is being slurried into the boring in order to allow the silica sand to settle and provide borehole stability around the lysimeter.

(8) After the silica sand backfill/slurrying is completed, a mixture of bentonite and sand will be slurried or introduced as a dry mix (as conditions dictate) via the previously described tremmy pipe in order to ensure a borehole seal above the lysimeter sampling horizon. A small amount of distilled water will be introduced to the bentonite/sand mixture if dry placement is elected.

(9) The auger will then be slowly withdrawn from the boring. The boring will be allowed to collapse below the withdrawn auger. The caved material will be tamped lightly with the auger as it is withdrawn in order to minimize preferred flow pathways for surface water recharge in the backfilled boring. It may be necessary to add native soil through the hollow-stem auger in order to achieve the desired backfill density above the silica sand and bentonite seal.

(10) The exposed surface tubing (PVC shroud and three sampling/pressure/vacuum lines) will be enclosed in a locking steel weather-tight surface casing or box, which will be set in a concrete pad.

D. Lysimeter Monitoring

(1) Attachment 7 shows a schematic diagram of the completed lysimeter installation and associated sampling equipment.

(2) After initial installation, a vacuum will be applied to the lysimeter to verify that the vacuum rate is, as a preliminary matter, indicative of the assembly's pressure integrity. Upon sucessfull recovery of an initial water sample, it will be

assumed that the lysimeter is working properly and FM Fox will be released from further responsibility for the lysimeter installation.

(3) The lysimeters will initially produce water which was used to slurry the silica sand backfill. The slurried silica sand backfill is necessary to: (a) ensure adequate placement and sealing of sand around the porous lysimeter intake cup and (b) to establish capillary contact with native soil moisture adjacent to the soil boring. Therefore, the specific conductance of the produced water will need to be monitored until "breakthrough" of native soil moisture is established. At this time it is unknown how long this breakthrough will take. However, SAI has scheduled four to six weeks for lysimeter monitoring and sample acquisition. It is anticipated that this will allow sufficient time to establish native soil moisture capillary flow under induced vacuum pressure gradient into the lysimeter. This assumption is contingent upon the presence of sufficient in-situ moisture and capillary flow connection.

(4) The following enumerated items describe the sequence of procedures that will be repeated during the lysimeter monitoring period. The reader is referred to Attachment 7.

(5) Valves 1 and 2 are closed and valves 3 and 4 are opened. A vacuum of approximately 14 to 16 inches of mercury is applied. Upon reaching the appropriate vacuum pressure, valves 3 and 4 are closed and the sampling appuratus is detached at the three connectors on the emerging surface sampling tubes adjacent to valves 1, 2 and 3. Note that a valve is assumed at the argon pressure tank and regulator.

(6) Depending upon the rate of vacuum decay, but no less frequently than twice per week, the lysimeter will be checked for vacuum decay and sample.

(7) Upon arrival at each lysimeter installation, the vacuum pump, pressure tank/regulator and sample bottle will be attached to the surface sampling tubing as shown in Attachment 7. Valves 3 and 4 will be opened and any residual vacuum pressure will be noted on the field data reporting form (see Attachment 8).

(8) Keeping valves 1, 2 and 4 closed, the argon pressure tank will be opened and the regulator adjusted to 5 to 10 psi. in order to transfer liquid sample from the vacuum lysimeter to the transfer vessel (see Attachment 6). The configuration of lysimeter and transfer vessel is necessary as the vacuum lysimeter vessel alone is not capable of withstanding the pressures necessary

to lift the water sample to the surface, and thus, must first be lifted to the transfer vessel prior to lift to the surface.

(9) Valves 1 and 2 are then opened while simultaneously closing valve 3 (valve 4 already closed). The argon pressure regulator is then opened further to a pressure of approximately 30 to 35 psi. in order to lift the liquid sample from the transfer vessel to the surface.

(10) Recovered sample volume and specific conductance will be measured and recorded on the field data reporting form (Attachment 8). The argon pressure tank valve is closed and the system is allowed to vent to atmospheric pressure via the sample delivery line.

(11) Valves 1 and 2 are then closed and valves 3 and 4 are opened. The vacuum pump is then used to reapply a vacuum of 14 to 16 inches of mercury to the vacuum lysimeter.

(12) Valves 3 and 4 are then closed and the surface sampling system is disconnected as previously described.

(13) The sample aliquot for chemical analyses will start to be collected after the cumulative volume which has been produced is equal to the volume of distilled water which was added to the slurried sand backfill and/or the conductivity shows stabilization. Some sample dilution may occur initially, but by monitoring the volume and conductivity of the produced water, it will be possible to provide some degree of determination as to the magnitude of the sample dilution.

E. Lysimeter Sample Storage, Shipment and Analyses

(1) Lysimeter water samples will be stored at the Kirtland AFB PX freezer storage locker during the interim period between initial sample collection and shipment to the La Jolla, Ca analytical laboratory. Samples will be stored in one liter Teflon bottles equipped with a check valve and pinch clamp to exclude contamination by atmospheric gases.

(2) When the lysimeter sample bottles have been filled, the sample bottles will be stored in insulated ice chests and shipped to the JRB lab in La Jolla, Ca. Chain-of-custody forms (Attachment 9) will be included with the samples as well as the sample labels which will be attached to each respective sample bottle. Chain-of-custody forms will be in duplicate, with a carbon retained in Albuquerque

and the original returned to Albuquerque with the reports of analyses.

(3) Attachment 1 describes the chemical analyses to be performed on each of the water samples. In order to provide quality control on the laboratory analyses, samples will be split (where volume allows) for blind duplicate analyses.

(4) If at the end of the lysimeter monitoring period, it has been determined that the vacuum lysimeters have failed to yield sufficient water for analyses, then the decision to opt for soil water extract analyses will be made. Procedures for chain-of-custody, blind duplicate QA/QC splits and analates will be identical for those described above for the water samples.

(5) The laboratory will be instructed to provide documentation on their internal QA/QC and analytical procedures, which will be included in the draft final report.

Tc

PARAMETERS

Landfills #1 - #4 One per lysimeter soil or water

TOX
Oil & Gas
Lead
Sodiaum
Iron
Pesticides
Scan for: 2,4-D
2,4,5-T
DDT isomers
Aldrin
Lindane
Dieldrin
Methoxychlor
Methoxychlor epoxide

RB-11

As Above except Add: Silver
Mercury

Attachment 1
Lysimeter Analysis Parameters

PROJECT NAME: Kirtland AFB, IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF 1

COLLECTION LOCATION: Kirtland AFB, NM | SAMPLERS: Brewer/FOX & Culver/SAI

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
F01-01-01	12/12/83	09:30	Soil	1	Ice Only	Analyses Attk
F01-01-05	12/12/83	09:40	Soil	1		
F01-01-10	12/12/83	09:45	Soil	1		
F01-01-15	12/12/83	09:58	Soil	1		
F01-01-20	12/12/83	10:15	Soil	1		
F01-01-30	12/12/83	10:29	Soil	1		

CHAIN OF CUSTODY NO. : 351-33-LF01-01-01

RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
X	12/12/83 15:30 Interim Storage	X
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:

Attachment 2 - Soil Sample Chain-of- Custody

SAI/JRB

Contract No.: 351-33 Bottle Number 1

Sample No.: LF 01-01-20

Sample Date: 12 Dec 83 Sample Time: 10:15

Sample Location: Kirtland AFB, NM.

ANALYSIS: ☐ Volatiles ☐ Semi-Volatiles ☐ Pesticides ☐ Metals

☐ Inorganics Other See Attached

Preservation: Ice Only Collector: FAITH / CULVER

Remarks: SAMPLE CONTAINER RINSED WITH DISTILLED WATER.

Chain of Custody No.: 351-33-LF-01-01-01

Attachment 2
Soil Sample Label

INSTALLATION RESTORATION PROGRAM
Phase II-B
Kirtland Air Force Base

LYSIMETER CLEANING AND TESTING

Date	Time	Lysimeter Number	Signature and firm	Comments

VACUUM DECAY TEST

Date: Lysim. No.: By:

Time	Vacuum Press	Time	Vacuum Press	Time	Vacuum Press

Project No.: 1-220-06-351-33 Page ______ of ______

Attachment 3

NOTE:

The original site maps prepared by FM Fox & Associates were on a 24"x 36" blueline format. Science Applications, Inc. has taken the liberty of including only xerox copies of the appropriate areas of these maps. These copies are at the original scale of 1" = 400' (legend and scale attached). Should you require a set of the original maps please contact Science Applications, Inc. at (505) 247-8787.

Attachment 4

LEGEND

EXPLORATION TEST HOLE
(Completed June 1983)

SEISMIC LINE LOCATION

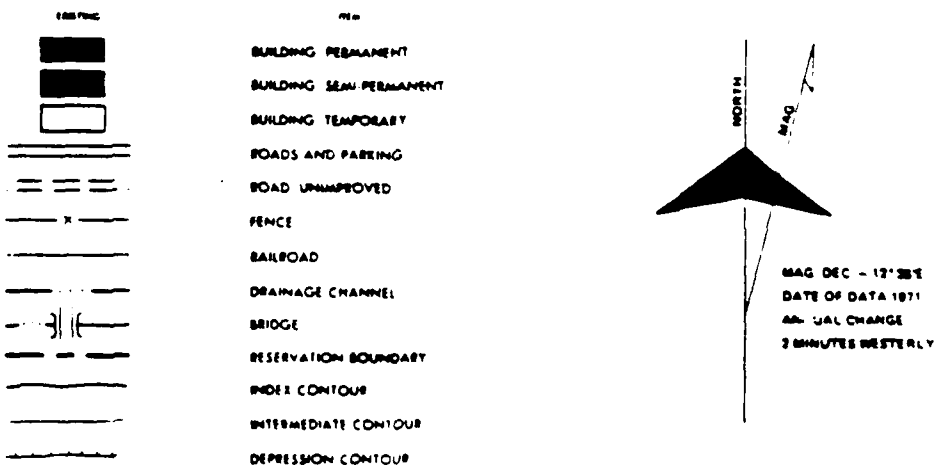
LANDFILL BOUNDARY
(Tentative Location June 1983)

PROPOSED DEDICATED MONITOR WELL

PROPOSED LYSIMETER and BEARING

LANDFILL BOUNDARY FROM PREVIOUS INVESTIGATIONS

SANITARY SEWER LINE BOREHOLE
(Molzen-Corbin & Assoc.,1977)

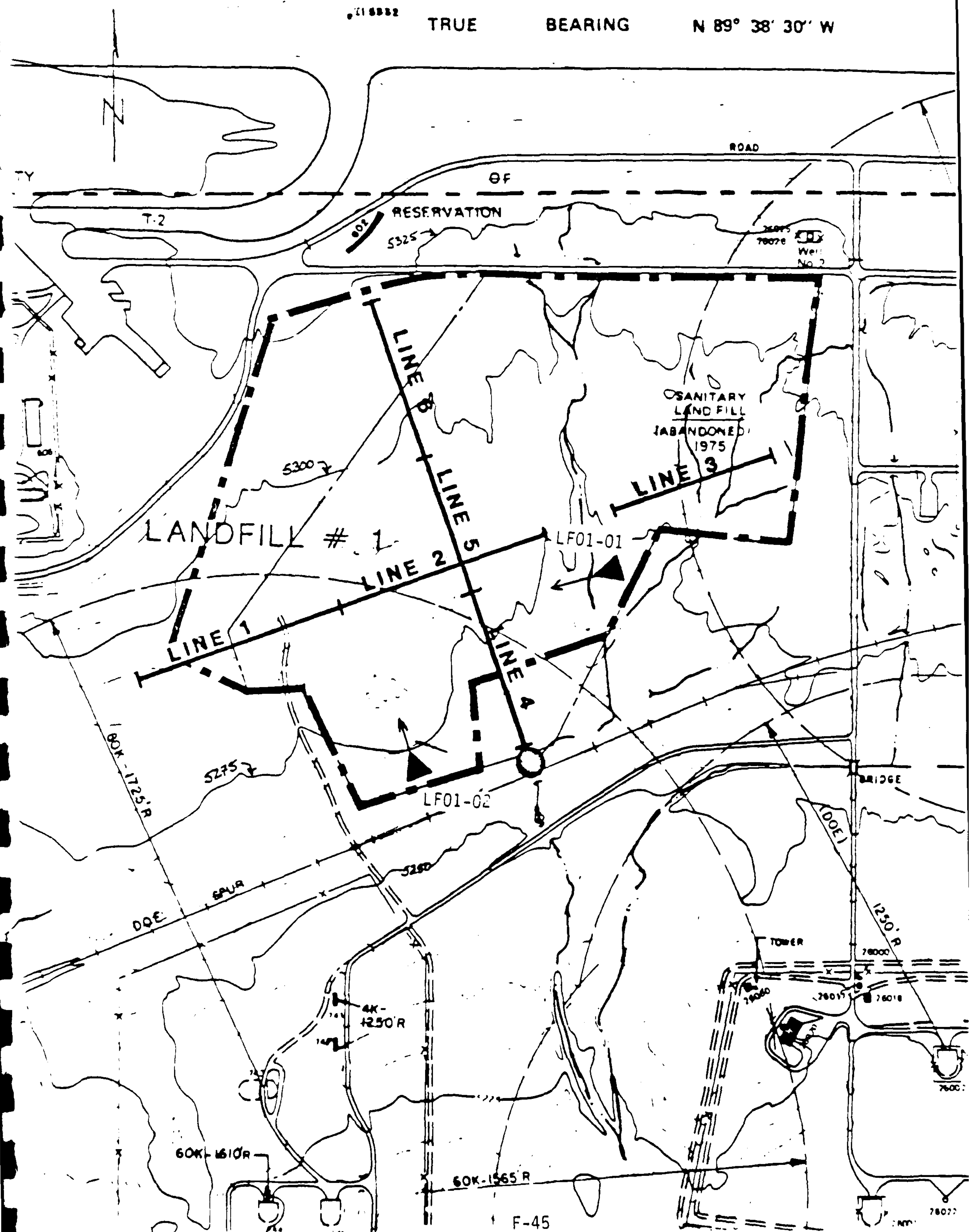


SCALE IN FEET

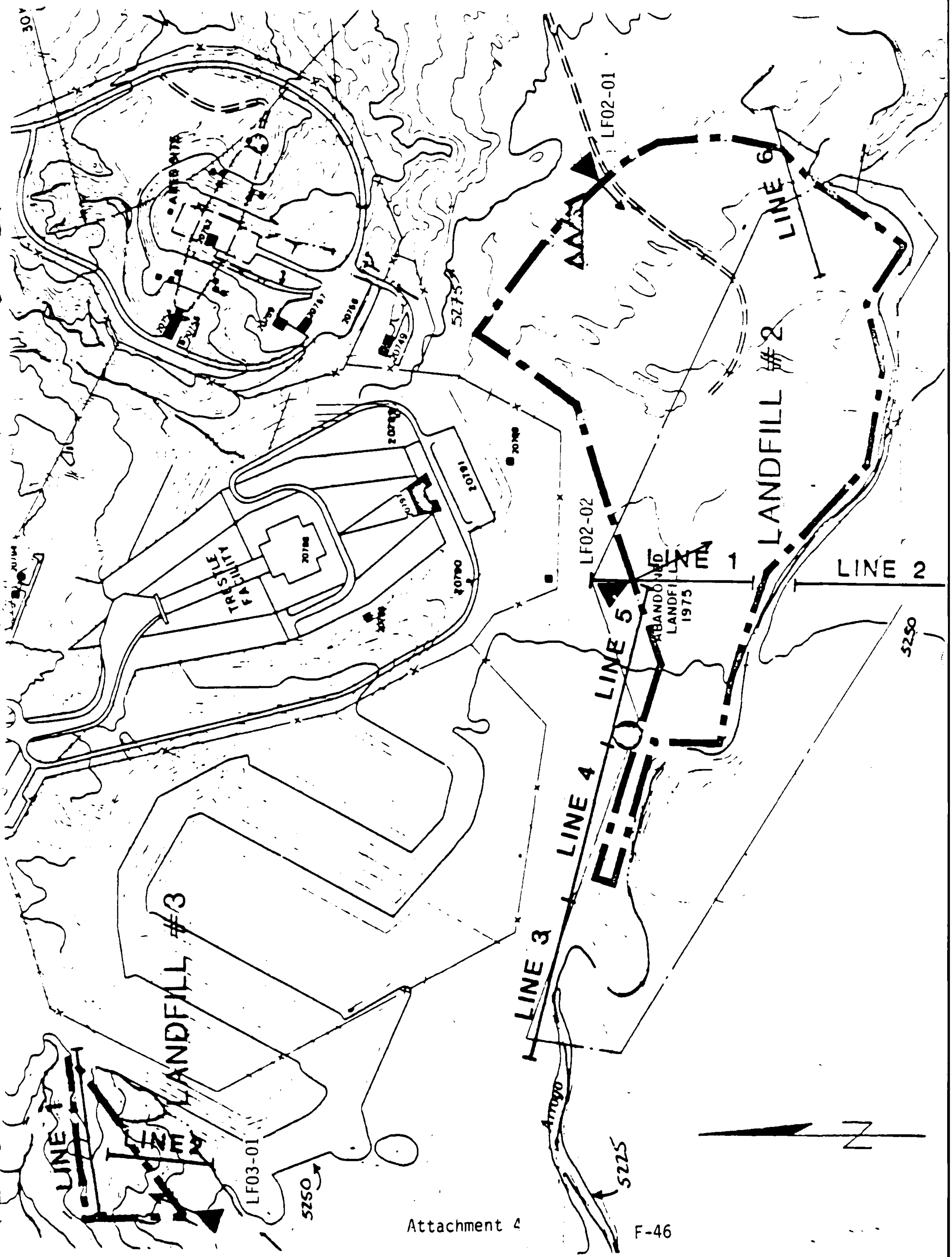
CONTOUR INTERVAL 5 AND 10 FEET

AIRFIELD ELEVATION 5352' R/W 26

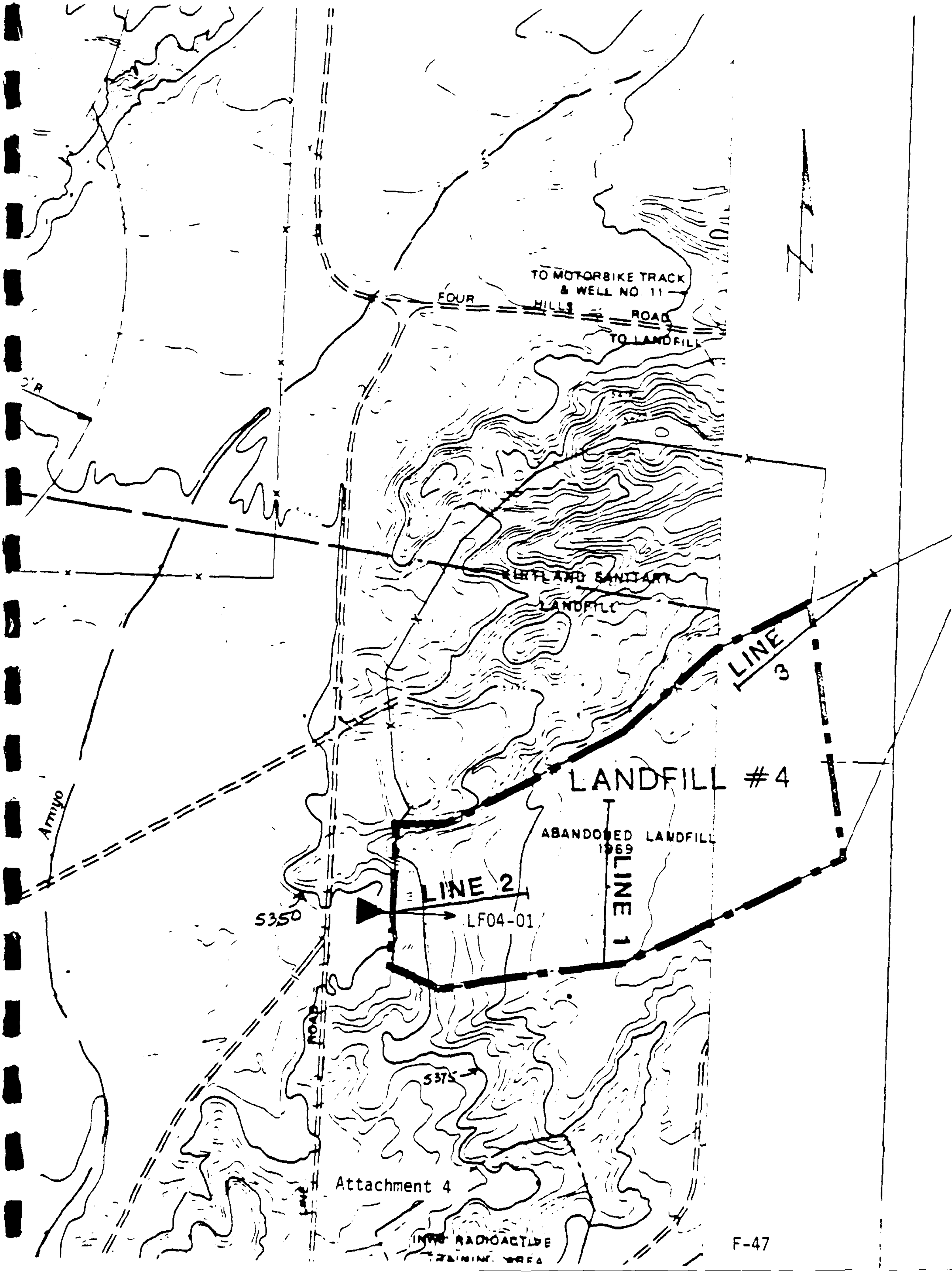
Attachment 4



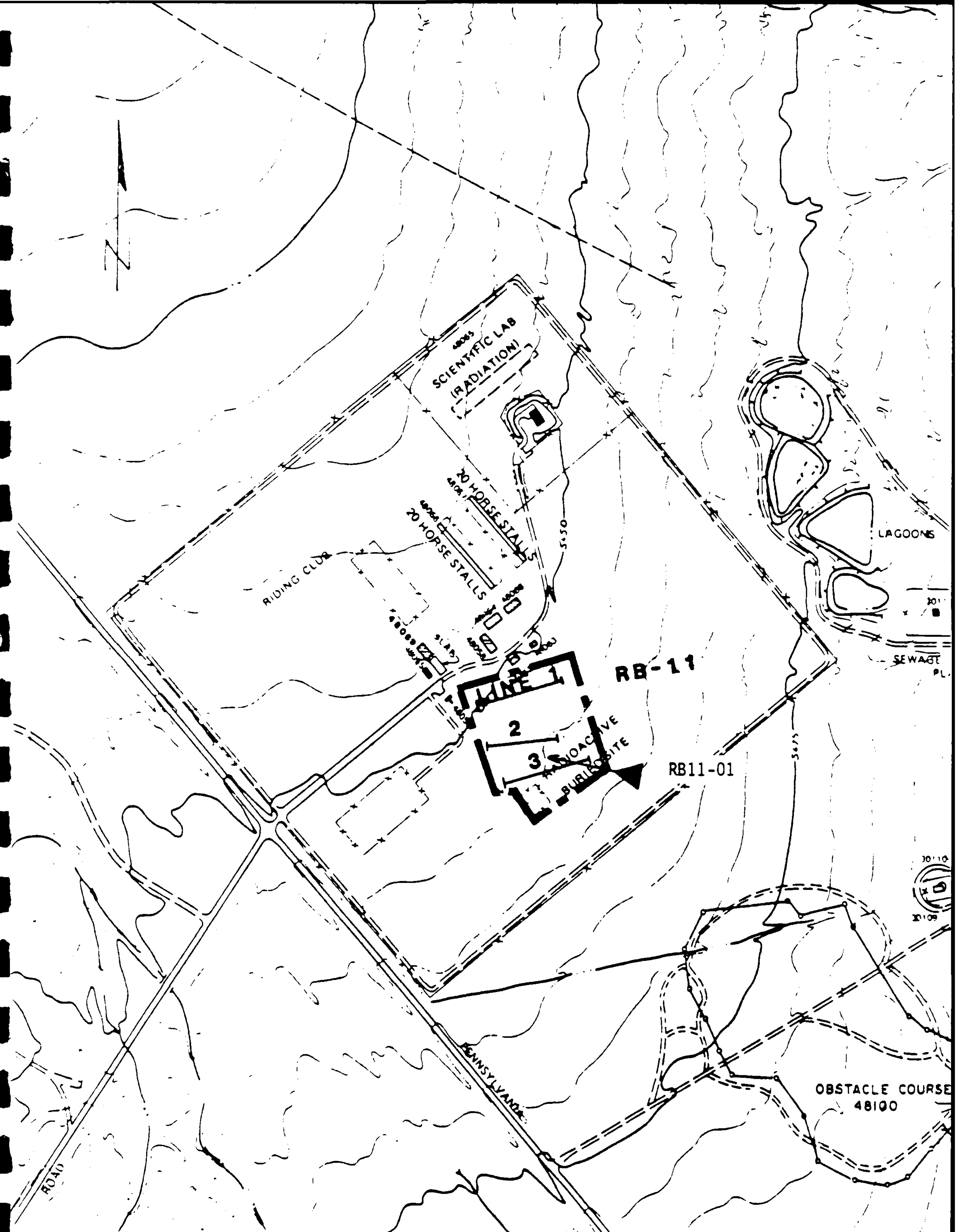
Attachment 4



Attachment 4



Attachment 4



Attachment 4

INSTALLATION RESTORATION PROGRAM

Phase II-B
Kirtland Air Force Base

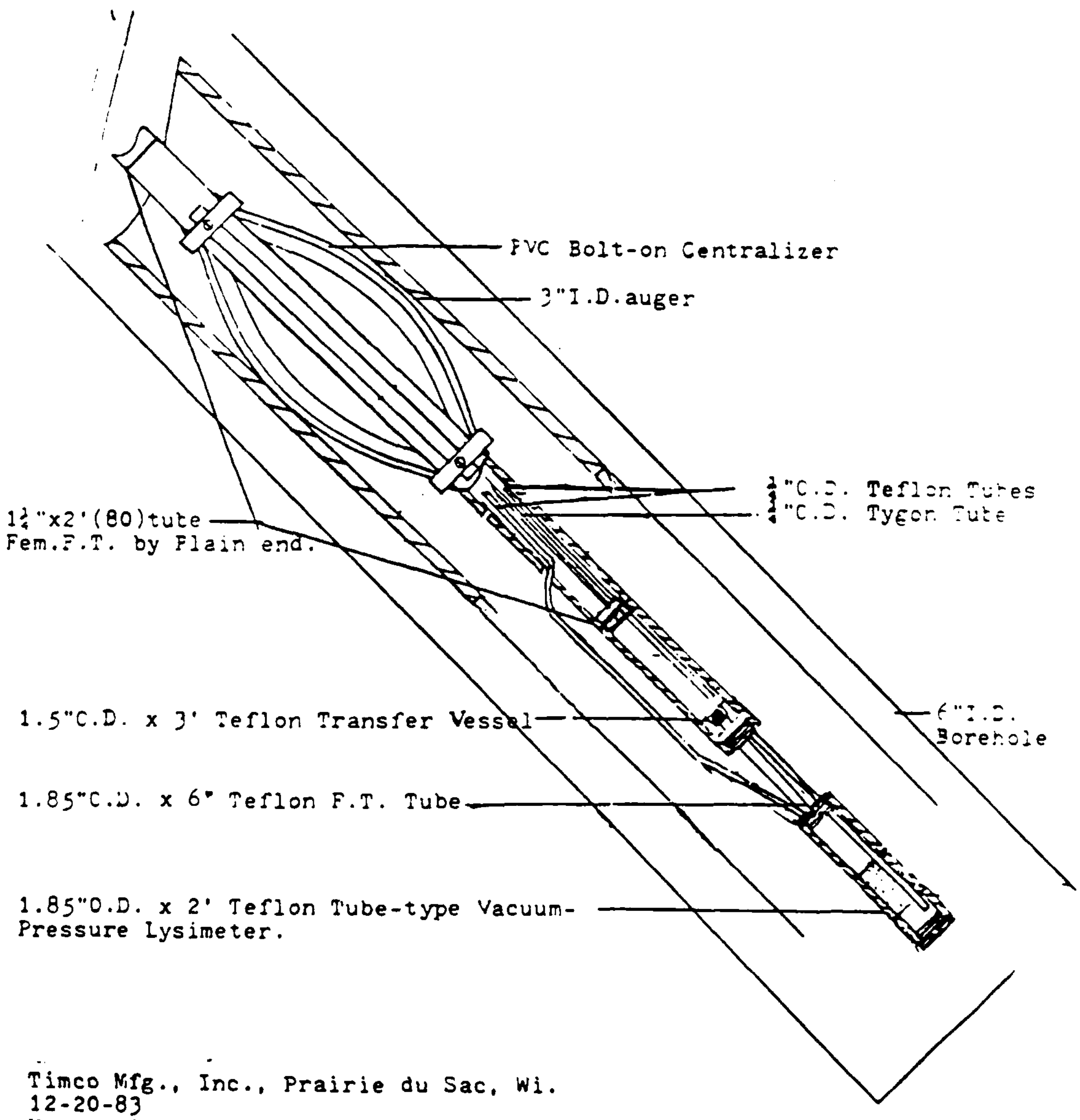
DRILLING RIG STEAM CLEANING VERIFICATION

DATE	TIME	BORING COMPLETED	NEXT BORING	SIGNATURE AND FIRM	COMMENT

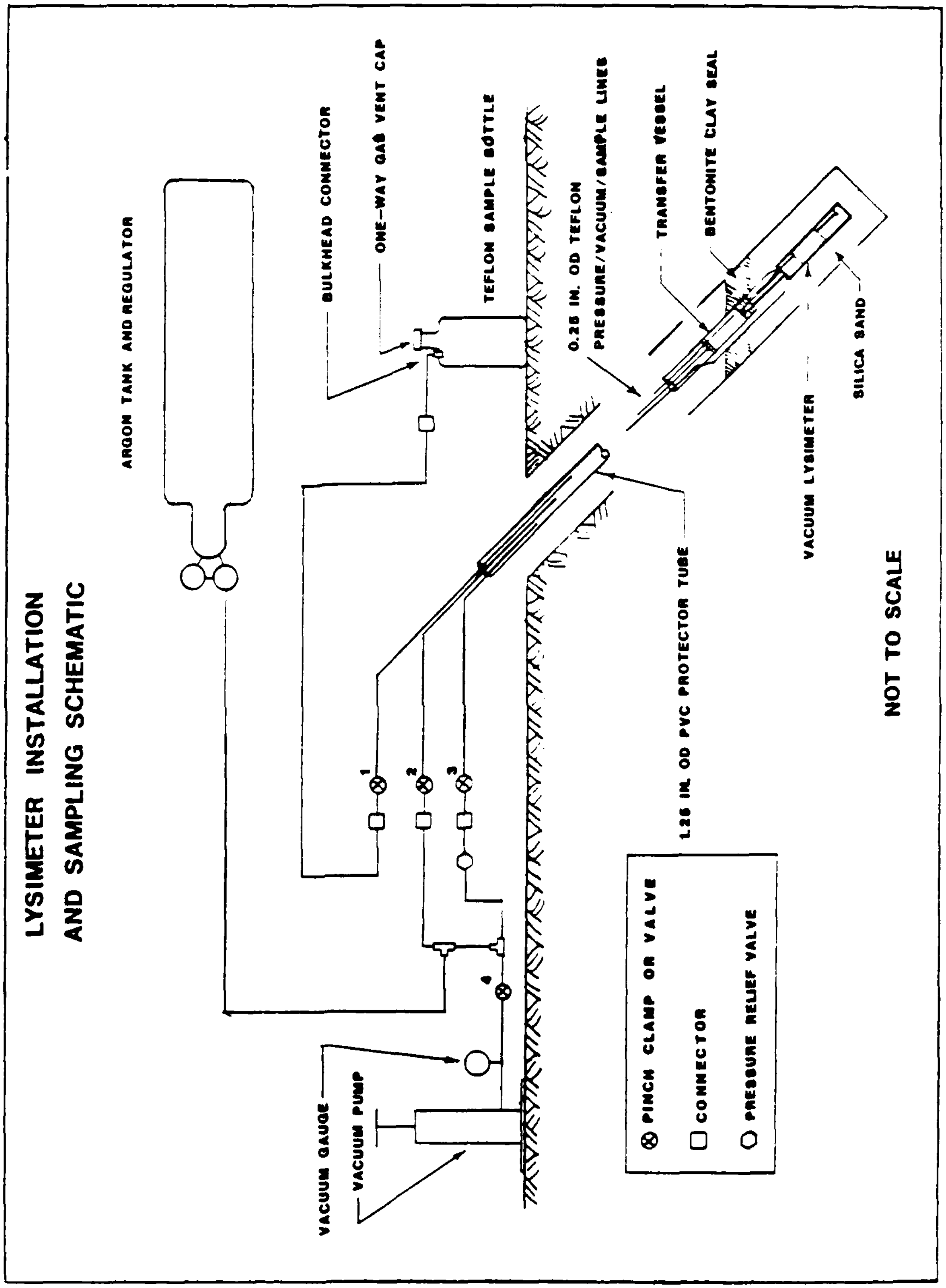
Project No: 1-220-06-351-33 | Page ______ of ______

Attachment 5

45 degree Angular Installation Utilizing Teflon Lysimeter With Transfer Vessel.



Timco Mfg., Inc., Prairie du Sac, Wi.
12-20-83
Hope Weitzel



Attachment 7

INSTALLATION RESTORATION PROGRAM - PHASE II B

Kirtland AFB, NM

Lysimeter No: ____________

LYSIMETER PRESSURE MONITORING

DATE	TIME	RESIDUAL PRESSURE	VOLUME/ CONDUCTIVITY	APPLIED PRESSURE	COMMENTS

Project No.: 1-220-06-351-33 Page _____ of _____

Attachment 8

PROJECT NAME: Kirtland AFB, IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF 1

COLLECTION LOCATION: Kirtland AFB, NM SAMPLERS: FAITH & CULVER /SAI.

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
LF02-02-01	12/20/83	09:00	Initial Press.			
	12/21/83	09:12	WATER	500ml	Ice Only	Freezer Storage
	12/21/83	15:20	WATER	350ml		
	12/22/83	08:40	WATER	350ml		
	12/23/83	09:08	WATER	300ml		
	12/23/83	10:00		1500ml (total)	Ice Only	Sealed for Shipping

CHAIN OF CUSTODY NO. : 351-33-LF02-01-01

RELINQUISHED BY:	DATE/TIME:	RECEIVED BY:
RELINQUISHED BY: X	DATE/TIME: 12/23/83 11:40 REASON: Shipment to Lab	RECEIVED BY: X
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: REASON:	RECEIVED BY:

Attachment 9 - Lysimeter Sample Chain-of-Custody

SAI/JRB Contract No.: 351-33 Bottle Number 1

Sample No.: LF02-01-70

Sample Date: 23 Dec. 83 Sample Time: 10:00

Sample Location: Kirtland AFB, NM

ANALYSIS: ☐ Volatiles ☐ Semi-Volatiles ☐ Pesticides ☐ Metals

☐ Inorganics Other See Attached

Preservation: Ice Only Collector: Faith / Culver

Remarks:

Lysimeter Waters: 20 Dec. to 23 Dec. 83 /04

Chain of Custody No.: EF 351-33-LF02-01-02

Attachment 9
Lysimeter Sample Bottle Label

Appendix G

ANALYTICAL DATA AND PROCEDURES

AND

CHAIN OF CUSTODY DOCUMENTATION

Table G.1 Summary of Fire Training Area Analyses

Sample No.[1]	TOX[2] (mg/Kg)	Oil and Grease[3] (mg/Kg)	Sample No.	TOX (mg/Kg)	Oil and Grease (mg/Kg)	Sample No.	TOX (mg/Kg)	Oil and Grease (mg/Kg)
FTA-01-01	Cl: ND[4] Br: ND I: ND	< 100	FTA-01-05	Cl: ND Br: ND I: ND	< 100	FTA-01-10	Cl: 3.6 Br: ND I: 0.06	< 100
FTA-02-01	Cl: 3.7 Br: ND I: ND	< 100	FTA-02-05	Cl: 3.7 Br: ND I: 0.08	< 100	FTA-02-10	Cl: 3.1 Br: ND I: ND	< 100
FTA-03-01	Cl: 3.6 Br: ND I: ND	< 100	FTA-03-05	Cl: ND Br: ND I: ND	ND	FTA-03-10	Cl: ND Br: ND I: ND	< 100
FTA-04-01	Cl: ND Br: ND I: ND	ND	FTA-04-05	Cl: ND Br: ND I: ND	ND	FTA-04-10	Cl: 0.5 Br: ND I: ND	ND
FTA-05-01	Cl: ND Br: ND I: ND	ND	FTA-05-05	Cl: 0.5 Br: ND I: ND	ND	FTA-05-10	Cl: 1.6 Br: ND I: ND	ND
FTA-06-01	Cl: ND Br: ND I: ND	ND	FTA-06-05	Cl: 0.8 Br: ND I: ND	ND	FTA-06-10	Cl: ND Br: ND I: ND	ND
FTA-07-01	Cl: 1.6 Br: ND I: ND	ND	FTA-07-05	Cl: 3.4 Br: ND I: ND	ND	FTA-07-10	Cl: 1.1 Br: ND I: ND	ND
FTA-08-01	Cl: 0.5 Br: ND I: ND	ND	FTA-08-05	Cl: 0.9 Br: ND I: 0.04	ND	FTA-08-10	Cl: 0.9 Br: ND I: ND	ND
FTA-09-01	Cl: ND Br: ND I: 0.08	3900	FTA-09-05	Cl: ND Br: ND I: ND	ND	FTA-09-10	Cl: ND Br: ND I: ND	ND
FTA-10-05	Cl: 4.9 Br: ND I: ND	1300	FTA-10-15	Cl: 3.3 Br: ND I: 0.1	6500	FTA-10-20	Cl: 3.8 Br: ND I: 0.1	1200

1) For FTA-01-05: FTA = Fire Control Training Area
   01 = Borehole No.
   05 = Depth of Sample (ft, BGS)
   All samples collected 3 November 1983.
2) TOX = Total Organic Halogen Scan - consisting of: organic Bromide (0.5), organic Chloride (0.04), organic Iodide (0.02). Detection limits in parentheses. mg/Kg = milligrams per kilogram
3) By infrared spectrophotometer.
4) ND = not detected; < 100 = detected but unquantafiable, concentration below indicated level.

Table G.2 Summary of Water Sampling at Wells DM-01 and DM-02, Kirtland Air Force Base, NM

PARAMETER	DM-01	DM-02
Screened Interval	415-465 ft, BGS(1)	378-428 ft, BGS
Total Depth	475 ft, BGS	438 ft, BGS
Static Water Level	421 ft, BGS	378 ft, BGS
Pump Intake	440 ft, BGS	398 ft, BGS
Pumping Rate	8 hrs at 1 gpm	5 hrs at 2 gpm
Field Conductivity	290 μmhos	650 μmhos
Collection Date	23 January 1984	27 January 1984
Sample Number	DM-01 #2	DM-02 #1
TOX (Haloscan)		
Organic Chloride	0.02 mg/l(2)	0.01 mg/l
Organic Bromide	ND(3)	0.004 mg/l
Organic Iodide	ND	ND
Total Organic Carbon	ND	ND
Nitrate Nitrogen	0.03 mg/l	4.0 mg/l

(1) Ft, BGS = feet below ground surface
(2) mg/l = milligrams per liter
(3) ND = not detected

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117 N. First Ann Arbor, Michigan 48104 (313) 662-3104

QUALITY CONTROL SUMMARY

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Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number:	A1630 Reference: JRB-Kirtland
Date Sample Received:	January 18, 1984
Date Samples Extracted:	No extraction
Date Samples Analyzed:	February 7, 1984, February 20, 1984
Methodology Employed:	Halocarbon Purgeables EPA Method 601 EPA 600 Method for chemical analysis of water and wastes. Methods 413.2, 416.1, 353.2
Sample Quality Control:	ERG's QA/QC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger. The enclosed Quality Control Summary this data.

Ann Arbor Chicago Cleveland San Francisco Minneapolis-St. Paul

QUALITY CONTROL SUMMARY

SAMPLE NUMBER	PARAMETER	DUPLICATE VALUE*	BLANK VALUE	METHOD SPIKE VALUE	SPIKE LEVEL	% RECOVERY
101159	Haloscan: Br^-	ND(0.04)ND(0.04)ppm	0	----------	----------	----------
101160	Haloscan: Br^-	ND(0.04)ND(0.04)ppm	0	----------	----------	----------
101183	Haloscan: Br^-	ND(0.04)ND(0.04)ppm	0	5.1	5.0 ppb	102
101159	Haloscan: Cl^-	ND(0.5) ND(0.5) ppm	0	----------	----------	----------
101160	Haloscan: Cl^-	ND(0.5) ND(0.5) ppm	0	----------	----------	----------
101183	Haloscan: Cl^-	0.5/1.6 ppm	0	48	50 ppb	96
101159	Haloscan: I^-	ND(0.02)ND(0.02)ppm	0	----------	----------	----------
101160	Haloscan: I^-	ND(0.02)ND(0.02)ppm	0	----------	----------	----------
101183	Haloscan: I^-	ND(0.02)ND(0.02)ppm	0	5.2	5.0 ppb	104
101165	Oil & Grease-I.R.	50.81/73.68 mg/Kg	1.4	----------	----------	----------
101170	Oil & Grease-I.R.	ND(100)ND(100)mg/Kg	1.4	----------	----------	----------
101182	Oil & Grease-I.R.	ND(100)ND(100)mg/Kg	1.4	----------	----------	----------
102099	TOC	1.4/1.4 mg/Kg	0.6	16.83	20 ppm	81
102188	Nitrate	0.00/0.00 mg/L	0.01	0.49	0.49 ppm	98

*ALL ANALYTICAL RESULTS ARE BLANK SUBTRACTED

erg ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

117 N. FIRST
ANN ARBOR, MICHIGAN 48104 (313) 662-3104

PROJECT A1630
REPORT DATE 02-23-84

CLIENT P.O.: WIEGAND
REPORT: 5520

SAMPLES RECVD: 02-01-84
REFER TECHNICAL QUESTIONS
TO: FRANK T. HAMMER

CLIENT:
JRB ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

ATTENTION: CLAUDIA WIEGAND

APPROVED: ____________

***
RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS
***

CLIENT I.D.: 84-5764
ERG SAMPLE NO: 01/101159
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5765
ERG SAMPLE NO: 01/101160
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5766
ERG SAMPLE NO: 01/101161
MATRIX: SOIL
DATE COLLECTED: 11-03-83

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PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.6	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg

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ERG PROJECT NO. A1630 - JRB ASSOCIATES, INC

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CLIENT I.D.: 84-5766
ERG SAMPLE NO: 01/101161
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
ORGANIC IODIDE	0.06	mg/Kg

CLIENT I.D.: 84-5767
ERG SAMPLE NO: 01/101162
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	1300	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	4.9	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5768
ERG SAMPLE NO: 01/101163
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	6500	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.3	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.1	mg/Kg

CLIENT I.D.: 84-5769
ERG SAMPLE NO: 01/101164
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	1200	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.8	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.1	mg/Kg

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CLIENT I.D.: 84-5770
ERG SAMPLE NO: 01/101165
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.7	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5771
ERG SAMPLE NO: 01/101166
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	2.8	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.08	mg/Kg

CLIENT I.D.: 84-5772
ERG SAMPLE NO: 01/101167
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.1	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5773
ERG SAMPLE NO: 01/101168
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.6	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

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CLIENT I.D.: 84-5774
ERG SAMPLE NO: 01/101169
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5775
ERG SAMPLE NO: 01/101170
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	<100	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5776
ERG SAMPLE NO: 01/101171
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5777
ERG SAMPLE NO: 01/101172
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

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ERG PROJECT NO. A1630 - JRB ASSOCIATES, INC 02-23-84

CLIENT I.D.: 84-5778
ERG SAMPLE NO: 01/101173
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.5	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5779
ERG SAMPLE NO: 01/101174
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5780
ERG SAMPLE NO: 01/101175
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.5	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5781
ERG SAMPLE NO: 01/101176
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	1.6	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

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CLIENT I.D.: 84-5782
ERG SAMPLE NO: 01/101177
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5783
ERG SAMPLE NO: 01/101178
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.8	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.03	mg/Kg

CLIENT I.D.: 84-5784
ERG SAMPLE NO: 01/101179
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5785
ERG SAMPLE NO. 01/101180
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.5	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

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ERG PROJECT NO. A1630 - JRB ASSOCIATES, INC 02-23-84

CLIENT I.D.: 84-5786
ERG SAMPLE NO: 01/101181
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.9	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.04	mg/Kg

CLIENT I.D.: 84-5787
ERG SAMPLE NO: 01/101182
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	0.9	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5788
ERG SAMPLE NO: 01/101183
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	1.1	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5789
ERG SAMPLE NO: 01/101184
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	1.6	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

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ERG PROJECT NO. A1630 - JRB ASSOCIATES, INC 02-23-84

CLIENT I.D.: 84-5790
ERG SAMPLE NO: 01/101185
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	3.4	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5791
ERG SAMPLE NO: 01/101186
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5792
ERG SAMPLE NO: 01/101187
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	ND (100)	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg

CLIENT I.D.: 84-5793
ERG SAMPLE NO: 01/101188
MATRIX: SOIL
DATE COLLECTED: 11-03-83

PARAMETER	RESULTS	UNITS
OIL AND GREASE BY IR	3900	mg/Kg
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.5)	mg/Kg
ORGANIC BROMIDE	ND (0.04)	mg/Kg
ORGANIC IODIDE	0.08	mg/Kg

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ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1630 - JRB ASSOCIATES, INC 02-23-84

CLIENT I.D.: DM-02 #1
ERG SAMPLE NO: 01/102099
MATRIX: NATURAL WATER
DATE COLLECTED: 01-27-84

PARAMETER	RESULTS	UNITS
CARBON, TOTAL ORGANIC,	ND (2)	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.01	mg/L
ORGANIC BROMIDE	0.004	mg/L
ORGANIC IODINE	ND (0.002)	mg/L
NITROGEN, NITRATE	4.0	mg/L

CLIENT I.D.: DM-01 #2
ERG SAMPLE NO: 01/102100
MATRIX: NATURAL WATER
DATE COLLECTED: 01-23-84

PARAMETER	RESULTS	UNITS
CARBON, TOTAL ORGANIC,	ND (2)	mg/L
HALOSCAN - T		
ORGANIC CHLORIDE	0.02	mg/L
ORGANIC BROMIDE	ND (0.004)	mg/L
ORGANIC IODINE	ND (0.002)	mg/L
NITROGEN, NITRATE	0.03	mg/L

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SR - SEE ATTACHED REPORT FOR RESULT
< - POSITIVE RESULT BUT AT UNQUANTIFIABLE CONCENTRATION BELOW INDICATED LEVEL

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THANK YOU FOR YOUR BUSINESS !

DOCUMENT CONTROL

SAMPLE CONTROL RECORD

ERG PROJECT NO. A1630

PARAMETER	SAMPLE NUMBERS	SIGNATURE OF ANALYST RESPONSIBLE FOR SAMPLES	DATE	TIME OUT	DATE	TIME IN
Hal-F	101157-101183	Tom [illegible]	2-1-84	9:30am	2-1-84	12 noon
NO3	102099-100	[illegible]	2-7-84	1:30pm	2-7	4:20
O&G IR	101159-173	Angela [illegible]	2-7	3:30		18:15
Hal-T	102099 to 2100	Tom [illegible]	2-7-84	7pm	2-21-84	10:15
O&G IR	101171, 74-88	Angela [illegible]	2/8	11:45		17:10
TOC	102099-102100	[illegible] Hutchinson	2/10/83	11:30am	2/10/84	5:00
TOX	~~101161-70~~ 157 160 RW	Tom D.	2/9/84	3:15	2/24/84	3:00

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ENC 14 Apr. 84

PROJECT NAME: Kirtland AFB/IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF 1

COLLECTION LOCATION: Albuquerque, NM | SAMPLERS: CULVER /SAI

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
DM 02 #1	27 JAN 84	14:02	WATER	1	Ice ONLY	TOC, TOX, NO_3
JRB #84-8345 AB						

CHAIN OF CUSTODY NO. : 351-33-DM-02-02

RELINQUISHED BY:	DATE/TIME / REASON	RECEIVED BY:
Clay M Culver	DATE/TIME: 30 Jan 84 15:00 REASON: SHIP TO LAB	SEE EMERY BILL # ABQ-26439
[signature] EMERY	DATE/TIME: 1020 1/31/84 REASON: Delivery	[signature] Process lab - JRB
[signature]	DATE/TIME: 1/31/84 2:45 PM REASON: Shipment for analysis	[signature] For FEDERAL EXPRESS
[signature] FEC	DATE/TIME: 2/1/84 10:50 AM REASON: RECIEVED AT ERG FROM FEDERAL EXPRESS	Greg Haydock

PROJECT NAME: Kirtland AFB/IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF 1

COLLECTION LOCATION: Albuquerque, NM				SAMPLERS: Culver/SAI		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
DM-01 #2	23 JAN 84	16:40	WATER	1	Ice ONLY	TOC, TOX, NO_3
JRB # 84-8344 AB						

Note: DM-01 #1 destroyed by container failure.

CHAIN OF CUSTODY NO.: 351-33-DM-01-02

RELINQUISHED BY:	DATE/TIME / REASON	RECEIVED BY:
Clay M Culver	DATE/TIME: 30 JAN 84 15:00 REASON: TRANSMIT TO LAB.	SEE EMERY BILL # ABQ-26439
Jeff Hodges EMERY	DATE/TIME: 1020 1/31/84 REASON: Delivery	D E [illegible] Process Lab - JRB
D E [illegible]	DATE/TIME: 1/31/84 245 PM REASON: Shipment for Analysis	[illegible] For Federal Express 1/31
[illegible] FEC	DATE/TIME: 2/1/84 10.50 AM REASON: RECIEVED AT ERG FROM FEDERAL EXPRESS	Greg [illegible]

PROJECT NAME: Kirtland AFB I.R.P. PROJECT NUMBER: 2-813-06-351-33 PAGE 1 OF 2

COLLECTION LOCATION: Kirtland AFB SAMPLERS: Culver

SAI SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
84-5764	11/3/83	09:19	Soil	1	None	TOX, Oil & Grease
5765	11/3/83	09:30	Soil	1	None	TOX, Oil & Grease
5766	11/3/83	09:40	Soil	1	None	Tox, Oil & Grease
5767	11/3/83	10:06	Soil	1	None	Tox, Oil & Grease
5768	11/3/83	10:27	Soil	1	None	Tox, Oil & Grease
5769	11/3/83	10:34	Soil	1	None	Tox, Oil & Grease
5770	11/3/83	10:54	Soil	1	None	Tox, Oil & Grease
5771	11/3/83	11:06	Soil	1	None	TOX, Oil & Grease
5772	11/3/83	11:14	Soil	1	None	TOX, Oil & Grease
5773	11/3/83	11:30	Soil	1	None	TOX, Oil & Grease
5774	11/3/83	11:36	Soil	1	None	TOX, Oil & Grease
5775	11/3/83	11:43	Soil	1	None	TOX, Oil & Grease
5776	11/3/83	11:52	Soil	1	None	TOX, Oil & Grease
5777	11/3/83	11:58	Soil	1	None	TOX, Oil & Grease
5778	11/3/83	12:06	Soil	1	None	TOX, Oil & Grease
5779	11/3/83	15:15	Soil	1	None	TOX, Oil & Grease
5780	11/3/83	15:09	Soil	1	None	TOX, Oil + Grease

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Michael K. Bechel	DATE/TIME: REASON: Shipment to ERG for Analysis	[illegible] FEC
(FED. EX. DELIVERYMAN) SIGNED OTHER COC FORM	DATE/TIME: JAN 13, 1984 10.30 AM REASON: RECEIVED BY E.R.G FROM FEDERAL EXPRESS DELIVERYMAN	Greg Haycock
Greg Haycock	DATE/TIME: JAN 18, 1984 1.25 PM REASON: TRANSFERRED CUSTODY TO SAMPLE CUSTODIAN	Robert K Ward
	DATE/TIME: REASON:	

AD-A227 088 INSTALLATION RESTORATION PROGRAM 4/4
CONFIRMATION/QUANTIFICATION STAGE 1 PHAS (U) SCIENCE
APPLICATIONS INTERNATIONAL CORP ALBUQUERQUE NM
UNCLASSIFIED 07 MAR 85 SAIC-2-827-06-351-33 F/G 24/7 NL

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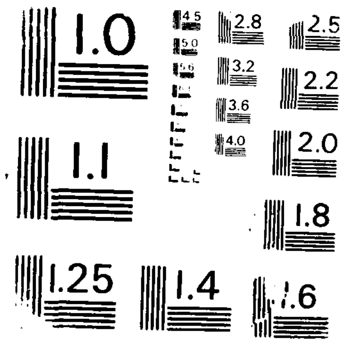
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PROJECT NAME: Kirtland AFB I.R.P. PROJECT NUMBER: 2-812-06-351-33 PAGE 2 OF 2

COLLECTION LOCATION: Kirtland AFB				SAMPLERS: Culver		
SAI SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
84-5781	11/3/83	15:05	Soil	1	None	TOX, Oil & Grease
5782	11/3/83	13:50	Soil	1	None	TOX, Oil & Grease
5783	11/3/83	13:56	Soil	1	None	TOX, Oil & Grease
5784	11/3/83	14:03	Soil	1	None	TOX, Oil & Grease
5785	11/3/83	14:13	Soil	1	None	TOX, Oil & Grease
5786	11/3/83	14:18	Soil	1	None	TOX, Oil & Grease
5787	11/3/83	14:24	Soil	1	None	TOX, Oil & Grease
5788	11/3/83	14:50	Soil	1	None	TOX, Oil & Grease
5789	11/3/83	14:37	Soil	1	None	TOX, Oil & Grease
5790	11/3/83	14:43	Soil	1	None	TOX, Oil & Grease
5791	11/3/83	12:26	Soil	1	None	TOX, Oil & Grease
5792	11/3/83	12:49	Soil	1	None	TOX, Oil & Grease
5793	11/3/83	12:20	Soil	1	None	TOX, Oil & Grease

TOX = Total Organic Halogens

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Michael K. Becker	DATE/TIME: ___ REASON: Shipment to ERG for analysis	(Shipment to ERG for analysis) FEC
[illegible] FEC	DATE/TIME: JAN. 18, 1984 10:30 AM REASON: RECEIVED BY ERG FROM FEDERAL EXPRESS DELIVERYMAN.	Greg Haycock
Greg Haycock	DATE/TIME: JAN. 18, 1984 1:25 PM REASON: TRANSFERRED CUSTODY TO SAMPLE CUSTODIAN.	Robert K. Ward
	DATE/TIME: ___ REASON:	

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: JRB 2-812-06-351 SAI-1-220-06-351-33 PAGE 1 OF ____

Chain of Custody No: 351-33-FTA-01

COLLECTION LOCATION:				SAMPLERS:		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
-01-01	11/3/83	09:19	Soil	1	None	Tox, Oil & Grease
FTA-01-05	11/3/83	09:30	Soil	1	None	Tox, Oil & Grease
A-01-10	11/3/83	09:40	Soil	1	None	Tox, Oil & Grease
~~FTA-10-01~~	~~11/3/83~~	~~10:01~~	~~Soil~~	Not Submitted ~~1~~	~~None~~	~~Tox, Oil & Grease~~
A-10-05	11/3/83	10:06	Soil	1	None	Tox, Oil & Grease
~~FTA-10-10~~	~~11/3/83~~	~~10:14~~	~~Soil~~	Not Submitted ~~1~~	~~None~~	~~Tox Oil & Grease~~
F A-10-15	11/3/83	10:27	Soil	1	None	Tox, Oil & Grease
FTA-10-20	11/3/83	10:34	Soil	1	None	Tox, Oil & Grease
A-02-01	11/3/83	10:54 ~~11:06~~	Soil	1	None	Tox, Oil & Grease
A-02-05	11/3/83	11:06	Soil	1	None	Tox, Oil & Grease
FTA-02-10	11/3/83	11:14	Soil	1	None	Tox, Oil & Grease
F A-03-01	11/3/83	11:30	Soil	1	None	Tox, Oil & Grease
FTA-03-05	11/3/83	11:34	Soil	1	None	Tox, Oil & Grease
F A-03-10	11/3/83	11:43	Soil	1	None	Tox Oil & Grease
FTA-04-01	11/3/83	11:52	Soil	1		
A-04-05	11/3/83	11:58	Soil	1		
F A-04-10	11/3/83	12:06	Soil	1		

Note TOX = Total organic halogens.

RELINQUISHED BY: Clayton Culver	DATE/TIME: 3Nov83 16:05 REASON: Ship samples to lab.	RECEIVED BY: J K Jugger
RELINQUISHED BY: Jeff Hodges EMERY AIR	DATE/TIME: Nov 4/1983 11:20AM REASON:	RECEIVED BY: Michael Beckel
RELINQUISHED BY:	DATE/TIME: ____ REASON:	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME: ____ REASON:	RECEIVED BY:

JRB - 2 - 812 - 06 - 351

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: ______ PAGE 1 OF 1

Chain of custody : 351-33 - FTA-02 SAI 1-220-06-351-33

COLLECTION LOCATION: Kirtland AFB, NM

SAMPLERS: Culver (SAI) & FM Fox & Assoc.

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
FTA-09-01	3 Nov 83	12:20	Soil	1	None	Tox, Grease & Oil
FTA-09-05	3/11/83	12:26	Soil	1	None	TOX, Oil/Grease
FTA-09-10	3/11/83	12:49	Soil	1	None	TOX, Oil & Grease
FTA-06-01	3/11/83	13:50	Soil	1	None	TOX, Oil & Grease
FTA-06-05	3/11/83	13:56	Soil	1	None	TOX, Oil & Grease
FTA-06-10	3/11/83	14:03	Soil	1	None	TOX, Oil & Grease
FTA-08-01	3/11/83	14:13	Soil	1	None	TOX, Oil & Grease
FTA-08-05	3/11/83	14:18	Soil	1	None	TOX, Oil & Grease
FTA-08-10	3/11/83	14:24	Soil	1	None	TOX, oil & Grease
FTA-07-01	3/11/83	14:37	Soil	1	None	TOX, Oil & Grease
FTA-07-05	3/11/83	14:43	Soil	1	None	TOX, Oil & Grease
FTA-07-10	3/11/83	14:50	Soil	1	None	TOX, Oil & Grease
FTA-05-01	3/11/83	15:05	Soil	1	None	TOX, Oil & Grease
FTA-05-05	3/11/83	15:09	Soil	1	None	TOX, Oil & Grease
FTA-05-10	3/11/83	15:15	Soil	1	None	TOX, Oil & Grease
	↑ 3 NOV 83					

TOX - TOTAL ORGANIC HALOGENS

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Clay M Culver	3 Nov 83 16:05 — Ship Samples to Lab	J K [illegible]
Jeff Hodges EMERY AIR	Nov 4 / 1983 11:20 AM	Michael K. Beck

FEDERAL EXPRESS

PLEASE COMPLETE ALL INFORMATION IN THE 5 BLOCKS OUTLINED IN ORANGE
SEE BACK OF FORM SET FOR COMPLETE PREPARATION INSTRUCTIONS

AIRBILL NUMBER 444589714

YOUR FEDERAL EXPRESS ACCOUNT NUMBER: [illegible]

DATE: 1/17/84

FROM (Your Name)	TO (Recipient's Name)
Michael Beckel	Maxine Hayes
COMPANY: [illegible] APPLICATIONS	COMPANY: ERG
STREET ADDRESS: [illegible] PROSPECT	STREET ADDRESS (P.O. BOX NUMBERS ARE NOT DELIVERABLE): 303 Ann Street
CITY: LA JOLLA STATE: CA	CITY: Ann Arbor, STATE: Michigan
ZIP: 92037	ZIP: 48104

If Hold For Pick-Up or Saturday Delivery Recipient's Phone Number

AIRBILL NO. 444589714

IN TENDERING THIS SHIPMENT SHIPPER AGREES THAT F.E.C. SHALL NOT BE LIABLE FOR SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM CARRIAGE HEREOF. F.E.C. DISCLAIMS ALL WARRANTIES EXPRESS OR IMPLIED WITH RESPECT TO THIS SHIPMENT. THIS IS A NON-NEGOTIABLE AIRBILL SUBJECT TO CONDITIONS OF CONTRACT SET FORTH ON REVERSE OF SHIPPER'S COPY. UNLESS YOU DECLARE A HIGHER VALUE, THE LIABILITY OF FEDERAL EXPRESS CORPORATION IS LIMITED TO $100.00. FEDERAL EXPRESS DOES NOT CARRY CARGO LIABILITY INSURANCE.

YOUR NOTES/REFERENCE NUMBERS (FIRST 12 CHARACTERS WILL ALSO APPEAR ON INVOICE): 2-812-06-361-33

PAYMENT: [X] Bill Shipper [ ] Bill Recipient's F.E.C. Acct. [ ] Bill 3rd Party F.E.C. Acct. [ ] Bill Credit Card [ ] Cash in Advance Account Number/Credit Card Number

SERVICES — CHECK ONLY ONE BOX

- PRIORITY 1: [X] 1 OVERNIGHT PACKAGES (up to 70 lbs.)
- OVERNIGHT LETTER: 6 [ ] (up to 2 oz.)
- COURIER PAK: 7 [ ]; 2 [ ] OVERNIGHT ENVELOPE (up to 2 lbs.); 8 [ ]; 3 [ ] OVERNIGHT BOX (up to 5 lbs.); 9 [ ]; 4 [ ] OVERNIGHT TUBE (up to 6 lbs.)
- STANDARD AIR: 5 [ ] DELIVERY 2ND BUSINESS DAY FOLLOWING PICK UP (up to 70 lbs.)

OVERNIGHT IS NEXT BUSINESS DAY (MONDAY THROUGH FRIDAY). TWO DAYS FROM ALASKA/HAWAII. SATURDAY DELIVERY AVAILABLE IN CONTINENTAL U.S. SEE "SPECIAL HANDLING."

DELIVERY AND SPECIAL HANDLING — CHECK SERVICES REQUIRED

1 [ ] HOLD FOR PICK-UP AT FOLLOWING FEDERAL EXPRESS LOCATION SHOWN IN SERVICE GUIDE. RECIPIENT'S PHONE NUMBER REQUIRED
2 [X] DELIVER
3 [ ] SATURDAY SERVICE REQUIRED
4 [ ] RESTRICTED ARTICLES SERVICE
5 [ ] SSS (Signature Security Service)
6 [ ] DRY ICE ____ LBS.
7 [ ] OTHER SPECIAL SERVICE
8 [ ]
9 [ ]

PACKAGES	WEIGHT	DECLARED VALUE	O/S
1	50		
TOTAL 2	TOTAL 100	TOTAL	

RECEIVED AT: SHIPPER'S DOOR; [ ] REGULAR STOP; [X] ON-CALL STOP; [ ] F.E.C. LOC.

Federal Express Corporation Employee No.: 15259

DATE/TIME For Federal Express Use: 1/17 1650

EMP. NO. / DATE; [ ] CASH RECEIVED; [ ] RETURN SHIPMENT; [ ] THIRD PARTY; [ ] CHG. TO DEL. [ ] CHG. TO HOLD; AGT/PRO; AGT/PRO

STREET ADDRESS; CITY; STATE; ZIP

RECEIVED BY (Signature): X Greg haycock

DATE/TIME RECEIVED; F.E.C. EMPLOYEE NUMBER

FEDERAL EXPRESS USE: FREIGHT CHARGES; DECLARED VALUE CHARGE; ADVANCE ORIGIN; ADVANCE DESTINATION; OTHER; TOTAL CHARGES

PART #2041730751 FEC-S-0751 O/O/B REVISION DATE 7/82 NCR PRINTED U.S.A.

Table G.3 Summary of Lysimeter Analyses

1) Parameter \ Landfill	LF01-01	4) LF01-02-A	4) LF01-02-B	LF02-01	LF02-02	LF03-01	LF04-02	RB11-01	Detection Limit
2) Depth	62 ft.	49 ft.	49 ft.	62 ft.	42 ft.	58 ft.	58 ft.	53 ft.	NA
Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	NA
Haloscan (TOX)									
Organic Chloride	ND 6)	ND	ND	ND	ND	ND	ND	ND	0.2 mg/Kg
Organic Bromide	ND	ND	ND	ND	ND	ND	ND	ND	0.05 mg/Kg
Organic Iodide	ND	ND	ND	ND	ND	ND	ND	ND	0.02 mg/Kg
Oil and Grease (by IR)	< 200	ND	ND	ND	ND	ND	ND	ND	200. mg/Kg
5) Lead, Total	8.	3.	< 3.	ND	ND	ND	5.	ND	3. mg/Kg
5) Sodium, Total	380.	180.	110.	60.	72.	68.	1200.	660.	
5) Iron, Total	22000.	26000.	22000.	44000.	86000.	9300.	28000.	18000.	
5) Mercury, Total	NA	NA	NA	NA	NA	NA	NA	< 0.1	0.1 mg/Kg
5) Silver, Total	NA	NA	NA	NA	NA	NA	NA	< 0.8	0.8 mg/Kg
2,4-D	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDT, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDE, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
DDD, p, p'-	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
3) Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	0.50 mg/Kg
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
Lindane	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	0.050 mg/Kg
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	ND	0.010 mg/Kg
2,4,5-T	ND	ND	ND	ND	ND	ND	ND	ND	0.0050 mg/Kg
Moisture	14%	12%	13%	2%	2%	3%	5%	5%	NA

1) All parameters reported in mg/Kg unless otherwise noted.
2) Drilled length, at 50° angle from horizontal, measured from surface.
3) Higher detection limit due to matrix interference (ERG Comment).
4) Duplicate analysis run on LF02-02-49.
5) Whole rock hydrofluoric digestion instead of water-soluble analytes.
6) ND = Not Detected, NA = Not Applicable to sample set. < = Positive result but unquantifiable. Concentration below indicated level.

QUALITY CONTROL SUMMARY

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number:	A #1931 Reference: JRB-Kirtland
Date Sample Received:	April 29, 1984
Date Samples Extracted:	May 17, 1984
Date Samples Analyzed:	May 27, 4, 19, 1984
Methodology Employed:	Halocarbon Purgeables EPA Method 601
	Aromatic Purgeables EPA Method 602
	Pesticides EPA Method 608
	Metals & Mercury
	Procedures for Handling & Chemical Analysis of Sediment & Water Samples
	ADA-103-788 EPA 1981
	Chemical Laboratory Manual - Bottom Sediments
	PB - 215 195
	EPA Federal Water Quality Administration 1969

QUALITY CONTROL SUMMARY

JRB: Kirtland: #A1931

SAMPLE NUMBER	PARAMETER	DUPLICATE VALUE*	BLANK VALUE	METHOD SPIKE VALUE	SPIKE LEVEL	% RECOVERY
** 107012	Chloride	ND(0.2)/ND(0.2)	0	94	100	94
107012	Bromide	ND(0.05)/ND(0.05)	0	12	10	120
107012	Iodide	ND(0.02)/ND(0.02)	0	10	10	100
106850	Lindane	ND(0.010)/ND(0.010)	ND(0.010)	0.04	0.04	100
106850	Aldrine	ND(0.010)/ND(0.010)	ND(0.010)	0.037	0.04	93
106850	DDE	ND(0.010)/ND(0.010)	ND(0.010)	0.079	0.08	99
106850	DDD	ND(0.010)/ND(0.010)	ND(0.010)	0.071	0.08	89
106850	DDT	ND(0.010)/ND(0.010)	ND(0.010)	0.076	0.08	96
106850	Heptachlor Epoxide	ND(0.010)/ND(0.010)	ND(0.010)	0.036	0.04	91
106850	Dieldrin	ND(0.10)/ND(0.10)	ND(0.10)	0.079	0.08	100
106850	Methoxychlor	ND(0.050)/ND(0.050)	ND(0.050)	------	-----	----
106850	2,4,D	ND(0.010)	ND(0.010)	0.0156	0.020	78
106850	2,4,5T	ND(0.0050)	ND(0.0050)	0.0067	0.0071	94
106845	Iron	22,400/20,800	0.099	0.213	0.25	85
106845	Lead	2.667/2.72	0.008	0.187	0.20	94
106845	Silver	0.48/0.54	0.00	0.220	0.20	110
106845	Sodium	104.76/112.18	0.0443	3.416	3.0	114
106850	Mercury	0.018/0.061	0.009	0.619	0.500	123
106846	Oil & Grease	ND(200)/ND(200)	ND(200)	------	------	----
106843	% Moisture	14/14	0	------	------	----

*All analytical results are blank subtracted

**This is a sample number that is not part of project A 1931, but was analyzed with the project A 1931.

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.
117 N. FIRST
ANN ARBOR, MICHIGAN 48104 (313) 662-3104

PROJECT A1931
REPORT DATE 05-30-84

CLIENT P.O.: LETTER
REPORT: 7224

SAMPLES RECVD: 04-20-84
REFER TECHNICAL QUESTIONS
TO: FRANK T. HAMMER

CLIENT:
JRB ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

APPROVED:

***
RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS
***

ATTENTION: CLAY CULVER-SAI

CLIENT I.D.: LF 01-01-62
ERG SAMPLE NO: 04/106843
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	<200	mg/Kg
LEAD, TOTAL	8	mg/Kg
SODIUM, TOTAL	380	mg/Kg
IRON, TOTAL	22000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.50)	mg/Kg
COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.		
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	14	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 01-02-49 (A)
ERG SAMPLE NO: 04/106844
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

CLIENT I.D.: LF 01-02-49 (A)
ERG SAMPLE NO: 04/106844
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	3	mg/Kg
SODIUM, TOTAL	180	mg/Kg
IRON, TOTAL	26000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg
COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.		
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	12	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 01-02-49 (B)
ERG SAMPLE NO: 04/106845
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	<3	mg/Kg
SODIUM, TOTAL	110	mg/Kg
IRON, TOTAL	22000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.50)	mg/Kg
COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.		
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

CLIENT I.D.: LF 01-02-49 (B)
ERG SAMPLE NO: 04/106845
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	13	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 02-01-62
ERG SAMPLE NO: 04/106846
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	ND (3)	mg/Kg
SODIUM, TOTAL	60	mg/Kg
IRON, TOTAL	44000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg

COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.

PARAMETER	RESULTS	UNITS
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	2	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 02-02-42
ERG SAMPLE NO: 04/106847
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	ND (3)	mg/Kg

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

CLIENT I.D.: LF 02-02-42
ERG SAMPLE NO: 04/106847
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
SODIUM, TOTAL	72	mg/Kg
IRON, TOTAL	86000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg
COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.		
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	2	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 03-01-58
ERG SAMPLE NO: 04/106848
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	ND (3)	mg/Kg
SODIUM, TOTAL	68	mg/Kg
IRON, TOTAL	9300	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg
COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.		
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	3	%
2,4,5-T	ND (0.0050)	mg/Kg

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

CLIENT I.D.: LF 04-02-58
ERG SAMPLE NO: 04/106849
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	5	mg/Kg
SODIUM, TOTAL	1200	mg/Kg
IRON, TOTAL	28000	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg

COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.

PARAMETER	RESULTS	UNITS
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	5	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: RB 11-01-53
ERG SAMPLE NO: 04/106850
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg
LEAD, TOTAL	ND (3)	mg/Kg
SODIUM, TOTAL	660	mg/Kg
IRON, TOTAL	18000	mg/Kg
MERCURY, TOTAL	<0.1	mg/Kg
SILVER, TOTAL	<0.8	mg/Kg
2,4-D	ND (0.010)	mg/Kg
DDT, p,p'-	ND (0.010)	mg/Kg
DDE, p,p'-	ND (0.010)	mg/Kg
DDD, p,p'-	ND (0.010)	mg/Kg
DIELDRIN	ND (0.10)	mg/Kg

CONTINUED

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

COMMENTS: HIGHER DETECTION LIMIT DUE TO MATRIX INTERFERENCE.

CLIENT I.D.: RB 11-01-53
ERG SAMPLE NO: 04/106850
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
ALDRIN	ND (0.010)	mg/Kg
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0.010)	mg/Kg
METHOXYCHLOR	ND (0.050)	mg/Kg
HEPTACHLOR EPOXIDE	ND (0.010)	mg/Kg
MOISTURE, PERCENT	5	%
2,4,5-T	ND (0.0050)	mg/Kg

CLIENT I.D.: LF 01-01-62.1
ERG SAMPLE NO: 04/107012
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	<200	mg/Kg

CLIENT I.D.: LF 02-01-62.1
ERG SAMPLE NO: 04/107013
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg

CLIENT I.D.: LF 02-02-42.1
ERG SAMPLE NO: 04/107014
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg

CONTINUED

 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1931 - JRB ASSOCIATES, INC 05-30-84

CLIENT I.D.: LF 03-01-58.1
ERG SAMPLE NO: 04/107015
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg

CLIENT I.D.: LF 04-02-58.1
ERG SAMPLE NO: 04/107016
MATRIX: SOIL

PARAMETER	RESULTS	UNITS
HALOSCAN - E		
ORGANIC CHLORIDE	ND (0.2)	mg/Kg
ORGANIC BROMIDE	ND (0.05)	mg/Kg
ORGANIC IODIDE	ND (0.02)	mg/Kg
OIL AND GREASE BY IR	ND (200)	mg/Kg

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SA - SEE ATTACHED REPORT FOR RESULT
- POSITIVE RESULT BUT AT UNQUANTIFIABLE CONCENTRATION BELOW INDICATED LEVEL

THANK YOU FOR YOUR BUSINESS !

DOCUMENT CONTROL

SAMPLE CONTROL RECORD

ERG PROJECT NO. A1931

Project Name URB-Kirtland

PARAMETER	SAMPLE NUMBERS	SIGNATURE OF ANALYST RESPONSIBLE FOR SAMPLES	DATE	TIME OUT	DATE	TIME IN
Soils	106843-50	Liz Justice	5/2/84	8:35am		
pH	106850	Robin Anderson	5-2-84	11:55a	5-2-84	3:20p.
Metals	106843-50	Angela Dismuke	5-2-84	3:20	5-2-84	4:30pm
TOX	106843-50	Tom Degenhardt	5-3-84	1pm	5-3-84	2pm
%OM	106843-850	Andy Dang	5-4-84	5:30pm	5-4-84	5:55pm
O&G	106843-850 107012-014	Andy Dang	5-8-84	4:10pm	5/8/84	10:30
Herb.	106843-50	Robert W Dunn	5-16-84	2:00pm	5-16-84	2:45pm
Herb	106843-50	Robert W Dunn	5-17-84	8:30AM	5-17-84	3:00P

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF ____

COLLECTION LOCATION:	SAMPLERS:

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
B11-01-12	6 Feb. 84	1130	soil	1	ice only	
[illegible]-01-23	6 Feb 84	1200	soil	1	ice only	
[illegible]-01-33	6 Feb. 84	1230	soil	1	ice only	
[illegible]-01-43	6 Feb. 84	1405	soil	1	ice only	
[illegible]01-53	6 Feb. 84	1521	soil	1	ice only	Sched B Analyses

CHAIN OF CUSTODY NO. : 351-33-RB11-01

RELINQUISHED BY:	DATE/TIME / REASON:	RECEIVED BY:
Stuart Smith	DATE/TIME: 13 Feb 1984 REASON: freezer storage	Stuart Smith
Stuart Smith	DATE/TIME: 4/15/84 1300 REASON: shipment	Clay M Culver
Clay M Culver	DATE/TIME: 4/18/84/16.00 REASON: Ship to CRG	SEE EMERY WORLDWIDE BILL # 04596
Eric Kent	DATE/TIME: 4/19/84 13:00 REASON: EMERY DELIVERY TO CRG BILL # 04596	Greg Lazarsh

PROJECT NAME: KAFB / IRP Phase II-B PROJECT NUMBER: 1-220-06-351-33 PAGE ____ OF ____

COLLECTION LOCATION: SAMPLERS:

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
04-01-13	2 Feb 84	1036	soil	1	ice only	
04-01-23	2 Feb 84	1100	soil	1	ice	[illegible] K-31
04-01-33	2 Feb. 84	~~1555~~ SF 1500	soil	1	ice	from 2nd boring
04-01-43	2 Feb 84	1600	soil	1	ice	
04-01-53	2 Feb 84	1720	soil	1	ice	
04-02-53	5 Feb. 84	1530	soil	1	ice	taken from 3rd boring
						note 1st & 2nd borings
					~~[illegible]~~	abandoned after
					Sched A Analyses	lysimeter installation
						difficulty
						sample w/ LF04-01
						designation is from
						1st boring
						LF04-02-58 from
						3rd successful boring

CHAIN OF CUSTODY NO. : 351-33-04-01

RELINQUISHED BY: Stuart Smith	DATE/TIME: 13 Feb 1984 REASON: freezer storage	RECEIVED BY: Stuart Smith
RELINQUISHED BY: Stuart Smith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	RECEIVED BY: Clay N Culver
RELINQUISHED BY: Clay N Culver	DATE/TIME: 4/18/84/1600 REASON: Ship to ERG	RECEIVED BY: SEE: EMERY WORLDWIDE Bill # 04596
RELINQUISHED BY: Clay N Culver	DATE/TIME: 4/23/84 REASON: Ship ~~corrected~~ sample LF04-02-58	RECEIVED BY: ~~Greg~~ Greg Haycock 4/24/84

PROJECT NAME: KAFB/IRP - Phase II-B PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF ____

COLLECTION LOCATION: LF-02-02 | SAMPLERS: FAITH

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
~~02-01-12~~	8 ~~Feb 84~~	SF				
-02-12	8 Feb 84	1250	soil	1	ice only	
-02-22	8 Feb 84	1330	"	"	"	
2-02-32	8 Feb 84		"	"	"	
-02-42	8 Feb 84		"	"	"	Sched A Analysis
02-02-52	8 Feb 84		"	"	"	

CHAIN OF CUSTODY NO.: 351-33-LF02-02

RELINQUISHED BY	DATE/TIME / REASON	RECEIVED BY
RELINQUISHED BY: Stuart Faith	DATE/TIME: 13 Feb. 84 REASON: freezer storage	RECEIVED BY: Stuart Faith
RELINQUISHED BY: Stuart Faith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	RECEIVED BY: Clay N Culver
RELINQUISHED BY: Clay N Culver	DATE/TIME: 4/18/84/16.00 REASON: Ship to ERG	RECEIVED BY: SEE EMERY WORLDWIDE Bill # 04596
RELINQUISHED BY: Carl Kurt	DATE/TIME: 4/19/84 10:00 REASON: EMERY DELIVERY TO ERG BILL # 04596	RECEIVED BY: [illegible signature]

PROJECT NAME: Kirtland ~~AFB~~ /IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF 1

COLLECTION LOCATION:				SAMPLERS:		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
	31 JAN 84					
03-01-10	31 Jan 84	12:10	Soil	1	Ice Only	
03-01-23	31 Jan 84	12:55	Soil	1	"	
03-01-33	31 Jan 84	13.47	Soil	1	"	
03-01-43	31 Jan 84	14:35	Soil	1		
03-01-53	31 Jan 84	15:42	Soil	1		
03-01-58	31 Jan 84	1640	Soil	1		Sched A Analyses
03-01-	31 Jan 84		Soil	1		
03-01-	31 Jan 84		Soil	1		
03-01-	31 Jan 84		Soil	1		

CHAIN OF CUSTODY NO. : 351-33-LF03-01-01

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Stuart Smith	DATE/TIME: 13 Feb 1984 REASON: freezer storage	Stuart Smith
Stuart Smith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	Clay N Culver
Clay N Culver	DATE/TIME: 4/18/84/16:00 REASON: Ship to ERG	SEE EMERY WORLDWIDE BILL # 04596
Vance Kurt	DATE/TIME: 4/19/84 10:00 REASON: EMERY DELIVERY TO ERG BILL # 04596	Greg Langcastle

PROJECT NAME: KAFB/IRP Phase II-B PROJECT NUMBER: 220-66-351-33 PAGE 1 OF ___

COLLECTION LOCATION: LF02-01				SAMPLERS: Faith		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
02-01-12	7 Feb 1984	1030	soil	1	ice only	
02-01-22	7 Feb 1984	1055	soil	1	ice only	
02-01-32	7 Feb 1984	1130	soil	1	ice only	
02-01-42	7 Feb 1984	1200	soil	1	ice only	
02-01-52	7 Feb 1984	1300	soil	1	ice only	
02-01-57	7 Feb 1984	1325	soil	1	ice only	
02-01-62	7 Feb.	1400	soil	1	ice only	Sched A Analyses

CHAIN OF CUSTODY NO. : 351-33-LF02-01

RELINQUISHED BY:	DATE/TIME / REASON	RECEIVED BY:
Stuart Faith	DATE/TIME: 13 Feb 1984 REASON: freezer storage	Stuart Faith
Stuart Faith	DATE/TIME: 4/18/84 / 1300 REASON: shipment to ERG	Clay M Culver
Clay M Culver	DATE/TIME: 4/18/84/16.00 REASON: ship to ERG	sec. EMERY WORLDWIDE Bill # 04596
Cane Kurt	DATE/TIME: 4/19/84 10:00 REASON: EMERY DELIVERY TO ERG BILL #04596	Greg Haycock

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF ___

COLLECTION LOCATION: Albuquerque NM				SAMPLERS: Culver / Faith		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
01-02-~~22~~ one	10 Feb 84	12:26	Soil	1	Ice only	
01-02-~~22~~ one	10 Feb 84	12:50	Soil	1	"	Contact in sampler -A = 2nd soil type
01-02-32	10 Feb 84	1335	Soil	1		silt kizy
01-02-34	10 Feb 84	1335	soil	1	"	fine sand
01-02-42	10 Feb 84	1405	soil	1	"	fine sand
01-02-~~42~~ 49	10 Feb 84	1420	soil	1	"	iron staining contact w/ 2 [illegible]
01-02-52	10 Feb 84	1445	soil	1	"	silty clay
						Sched A Analyses

CHAIN OF CUSTODY NUMBER: 351-33-LF01-02

RELINQUISHED BY:	DATE/TIME / REASON	RECEIVED BY:
Stuart Smith	DATE/TIME: 15 Feb. 1984 REASON: freezer storage	Stuart Smith
Stuart Smith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	Clay N Culver
Clay N Culver	DATE/TIME: 4/18/84/16:00 REASON: ship to ERG	See: EMERY WORLDWIDE BILL # 04596
Vere Kant	DATE/TIME: 4/19/84 10:00 REASON: EMERY DELIVERY TO ERG BILL #04596	Greg [illegible]

PROJECT NAME: Kirtland AFB IRP PROJECT NUMBER: 1-220-06-351-33 PAGE 1 OF ___

COLLECTION LOCATION: Albuquerque Nill				SAMPLERS: Culver		
SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	# OF CONTAINERS	PRESERVATIVES ADDED	REMARKS
F-01-01-12	9 Feb 84	14:07	Soil	1	None - Ice only	
F[illegible]01-01-22	9 Feb 84	14:35	Soil	1	"	
F-01-01-32	9 Feb 84	15:18	Soil	1	"	
F[illegible]1-01-42	9 Feb 84	15:52	Soil	1	"	
F-01-01-52	9 Feb 84	16:28	Soil	1	"	
F[illegible]-01-57	9 Feb 84	16:50	Soil	1	"	
F[illegible]01-62	16 Feb 84	08:22	Soil	1	"	Sched A. Analyses
~~F-01-01-67~~	~~16 Feb 84~~		~~Soil~~	~~1~~	~~"~~	~~TO GC'S ERC~~

CHAIN OF CUSTODY NUMBER: 351-33-LF01-01

RELINQUISHED BY:	DATE/TIME / REASON	RECEIVED BY:
Stuart Smith	DATE/TIME: 13 Feb 1984 REASON: freezer storage	Stuart Smith
RELINQUISHED BY: Stuart Smith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	RECEIVED BY: Clayton Culver
RELINQUISHED BY: Clayton Culver	DATE/TIME: 4/18/84/16:00 REASON: ship to ERG	RECEIVED BY: See Emery Worldwide Bill # 04596
RELINQUISHED BY: Paul Kurt	DATE/TIME: 4/19/84 10:00 REASON: Emery delivery to ERG Bill # 04596	RECEIVED BY: Greg Laycock

PROJECT NAME: KAFB / IRP Phase II-B PROJECT NUMBER: 1-220-a 351-33 PAGE ___ OF ___

COLLECTION LOCATION:				SAMPLERS:		
SAMPLE NUMBER	**DATE**	**TIME**	**SAMPLE TYPE**	**# OF CONTAINERS**	**PRESERVATIVES ADDED**	**REMARKS**
FC4-01-13	2 Feb 84	1236	soil	1	ice only	
F[illegible]-01-23	2 Feb 84	1100	soil	1	ice	auger refusal @ 31'
C4-01-33	2 Feb 84	~~1135~~ SF 1500	soil	1	ice	from 2nd boring
F[illegible]-01-43	2 Feb 84	1600	soil	1	ice	"
[illegible]-01-53	2 Feb 84	1720	soil	1	ice	"
F04-02-53	5 Feb. 84	1530	soil	1	ice	taken from 3rd boring
						note: 1st & 2nd borings
					~~Sample~~	abandoned due to
					Sched A Analyses	equipment installation
						difficulty
						samples w/ LFC4-01
						designation are from
						1st boring
						LFC4-02-5x from
						3rd successful boring

CHAIN OF CUSTODY NO. : 351-33-04-01

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Stuart Faith	DATE/TIME: 3 Feb 1984 REASON: freezer storage	Stuart Faith
Stuart Faith	DATE/TIME: 4/18/84 - 1300 REASON: shipment to ERG	Clay N Culver
Clay N Culver	DATE/TIME: 4/18/84/16.00 REASON: Ship to ERG	SEE: EMERY WORLDWIDE Bill # 04596
Carl Kuit	DATE/TIME: 4/19/84 10:00 REASON: EMERY DELIVERY TO ERG BILL # 04596	Greg Laycock

CHAIN OF CUSTODY NUMBER: LF-04-02-58 page 2

RELINQUISHED BY:	DATE/TIME: / REASON:	RECEIVED BY:
Note: on 18 April 84 inadvertenly submitted LF04-01-53.		
Stuart Smith	DATE/TIME: 23 April 84; 12:50 REASON: Ship Sample LF04-02-58 to ERG, Inc.	Clay M Culver
Clay M Culver	DATE/TIME: 23 Apr 84; 16:40 REASON: SAMPLE SHIPMENT TO ERG (LF04-02-58)	SEE EMERY WORLDWIDE BILL # 04611
EMERY WORLDWIDE BILL # 04611	DATE/TIME: APRIL 24, 1984 10:00 REASON: RECEIVED AT ERG	Greg Haycock
Greg Haycock	DATE/TIME: APRIL 24 1984 [illegible] REASON: TRANSFERRED CUSTODY TO SAMPLE CUSTODIAN	[illegible]
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	
	DATE/TIME: ____ REASON:	

EMERY WORLDWIDE

U.S.A. / CANADA SERVICES*

[X] AM SERVICE
[ ] PM SERVICE
[ ] Other ______
[ ] Saturday Delivery Required

International (see below)

*See reverse side of this copy for conditions under which service is available.

Shipper's Account Number: KY-0SA505 | Date: 4/23/84 | Origin Office: ABQ | Shipment Number: 04611

From
Clay Culver
SCIENCE APPLICATIONS INC
505 MARQUETTE NW
ALBUQUERQUE NM | Zip Code (Required): 87102

Shipper's Reference No: 1-220-06-351-33 | Declared Value: $

Collect Shipper's Charges on Delivery: **C.O.D.** $ ______
[ ] Company Check Payable to Shipper Acceptable

To
Environmental Research Group, Inc.
ATTN: Ms. Maxine Haynes
117 North First Street
Ann Arbor, MI | Zip Code (Required): 48104

Consignee's Account No: | Consignee's Reference No.:

Number of Pieces	Description and Marks (Check Here If [ ] Urgent Letter [ ] Emery Envelope)	Commodity Code	Weight	Pcs.	L	W	H
1	Ice Chest - Soil Sample	FE	9	1	8	8	10

SPECIAL INSTRUCTIONS [ ] GOVT.

Subject to terms and conditions on reverse. Shipper's Signature X

INTERNATIONAL SERVICES
[ ] FIRST CLASS
[ ] BUSINESS CLASS
[ ] STANDARD CLASS
[ ] Other ______
Declared Value for Customs $
International Insurance Amount $

Form of Payment [X] Prepaid [ ] Collect [ ] GBL

[ ] Cash or Check on Pick Up $ ______ Received By (Initials) ______

[ ] **Bill To:** (Address Below) Paying For [ ] Shipper [ ] Consignee [ ] Third Party

Goods Received At [X] Shipper's Door [ ] Residence Door [ ] City Terminal [ ] Airport Terminal [ ] Carrier's Advance [ ] Other Carrier's Door [ ] Drop Box

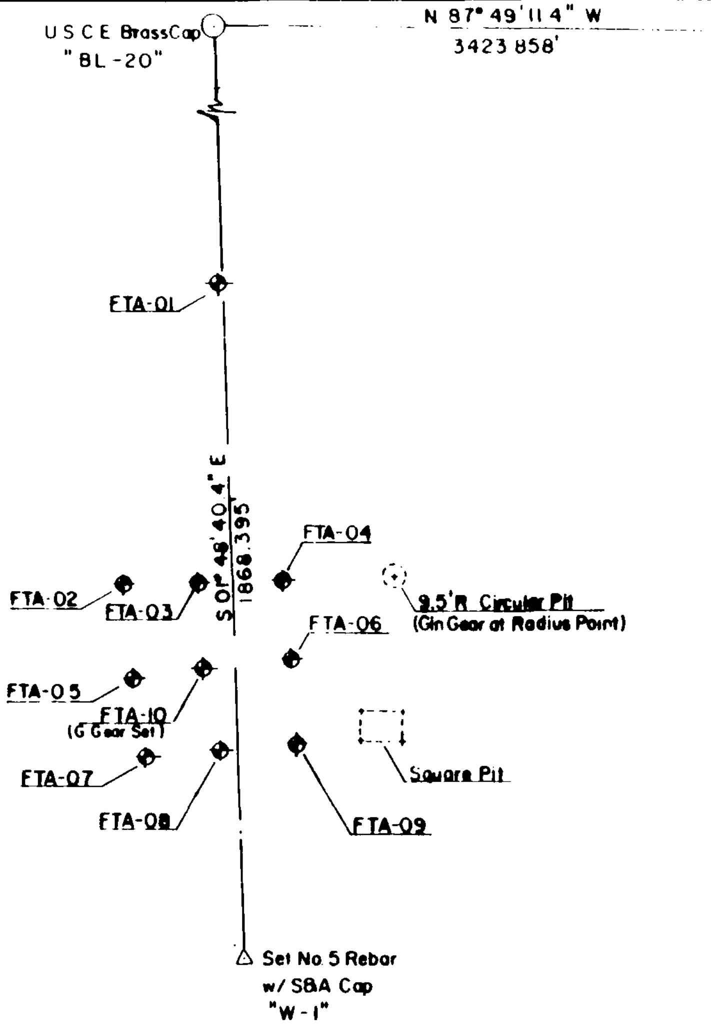
Time: 4:40 | Date: 4-23-84 | No Shipments This Stop: 6

By: | Advance At Origin $

Non-Negotiable Airbill
Form OP-1 Rev 4-83 Printed in U S A
Executive Offices Wilton, Connecticut 06897
1 - Consignee's Copy

APPENDIX H

Survey Data



LEGEND

- ⌖ BOUNDARY MARKER
- BORE HOLE
- WELL
- ▽ CONTROL POINT
- ⊙ MONUMENT

	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL *	"BL-20"	394,399.44	1,471,110.88	5315.956
	"W-1"	394,458.49	1,469,243.42	5317.429
	R.P. Circ Pit	394,581.41	1,469,555.49	5314.062
	Sq. Pit, NE Cor	394,588.73	1,469,445.14	5313.912
	" SE Cor.	394,588.15	1,469,421.00	5313.842
	" SW Cor.	394,553.91	1,469,421.68	5313.912
	" NW Cor	394,554.54	1,469,445.94	5313.882
BORE HOLES	FTA-01	394,436.71	1,469,796.31	5313.892
	FTA-02	394,357.82	1,469,549.47	5312.092
	FTA-03	394,419.86	1,469,550.71	5312.752
	FTA-04	394,489.52	1,469,552.12	5312.742
	FTA-05	394,366.90	1,469,471.99	5312.652
	FTA-06	394,496.11	1,469,488.45	5313.302
	FTA-07	394,377.04	1,469,408.04	5312.292
	FTA-08	394,438.10	1,469,413.66	5312.702
	FTA-09	394,501.01	1,469,418.51	5313.182
	FTA-10	394,423.91	1,469,480.12	5313.012
*	BL-14A	397820.82	1470980.63	5323.840

SCIENCE APPLICATIONS INC.

KAFB SURVEY LANDFILL SITES

FIRE TRAINING AREA

DATE	JOB NO.	SCALE	DRW DW	SHT 1
MAR '84	84112	1" = 100'	CHK CA	OF 6

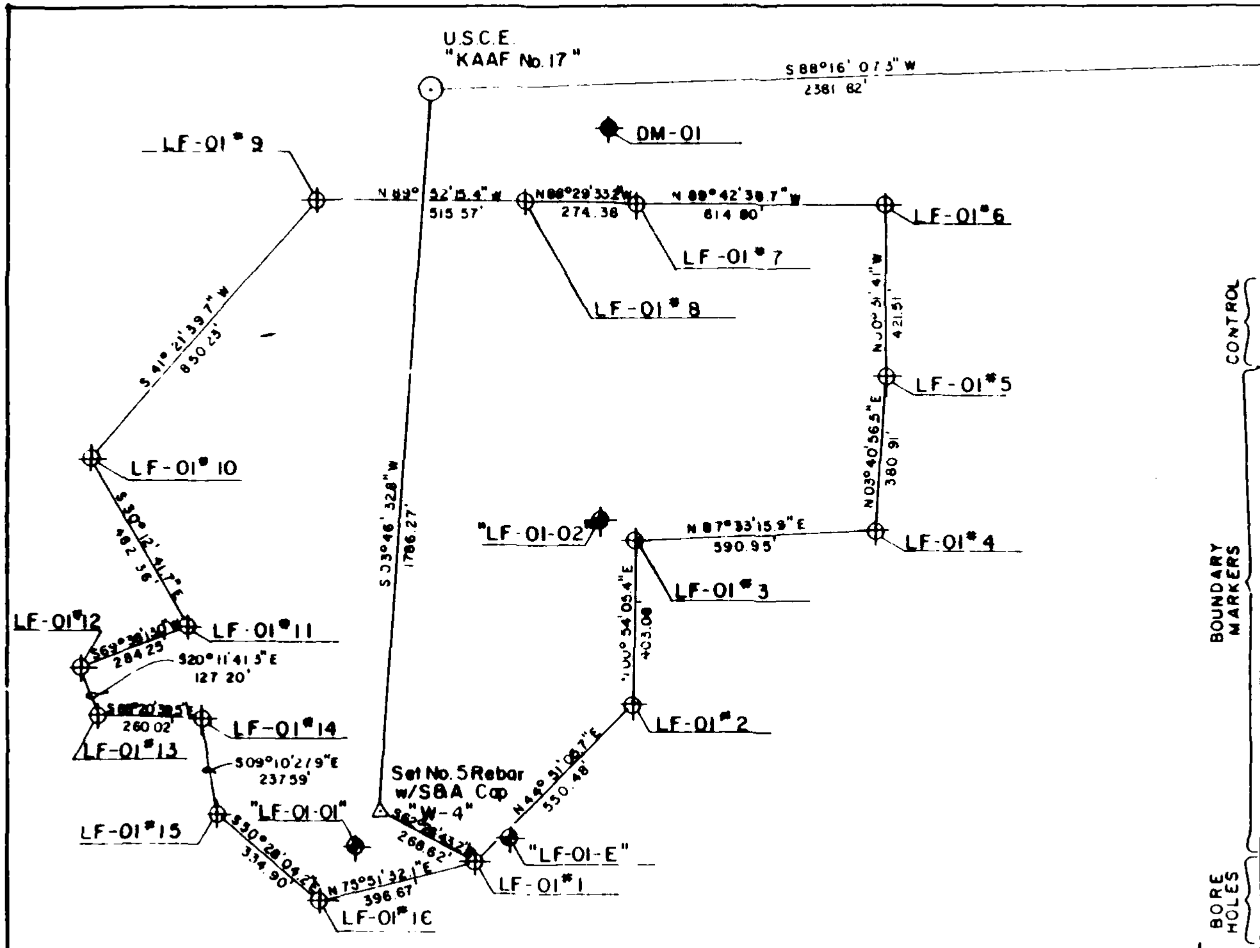
SCANLON & ASSOCIATES

SURVEY CERTIFICATE

I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL FIELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

THOMAS H. WAGNER N.M.P.L.S. NO. 3517 — DATE

THOMAS H. WAGNER NEW MEXICO 3517 REGISTERED PROFESSIONAL LAND SURVEYOR



LEGEND

- BOUNDARY MARKER
- BORE HOLE
- WELL
- CONTROL POINT
- MONUMENT

	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL	"BL-16A"	401828.20	1470936.29	5345.235
	"KAAF No.17"	399447.47	1470864.33	5330.426
	"W-4"	399329.84	1469081.94	5284.758
BOUNDARY MARKERS	LF-01 #1	399567.99	1468957.68	5255.310
	LF-01 #2	399956.23	1469347.94	5263.975
	LF-01 #3	399962.57	1469750.97	5275.522
	LF-01 #4	400552.99	1469776.18	5294.422
	LF-01 #5	400577.45	1470156.31	5294.175
	LF-01 #6	400573.57	1470577.80	5312.570
	LF-01 #7	399958.77	1470580.71	5303.998
	LF-01 #8	399684.49	1470588.12	5309.927
	LF-01 #9	399168.93	1470589.29	5323.301
	LF-01 #10	398607.10	1469951.14	5305.848
	LF-01 #11	398849.82	1469534.29	5289.043
	LF-01 #12	398583.34	1469435.38	5293.419
	LF-01 #13	398627.25	1469316.00	5289.886
	LF-01 #14	398887.16	1469308.49	5280.563
	LF-01 #15	398925.04	1469073.94	5272.987
	LF-01 #16	399183.34	1468860.77	5257.989
BORE HOLES	"LF-01-01"	399271.81	1468995.33	5263.222
	"LF-01-02"	399874.09	1469800.36	5275.749
	"LF-01-E"	399653.25	1469016.64	5257.512
WELL	"DM-01"	399891.91	1470767.39	5318.422

SCIENCE APPLICATIONS INC.

KAFB SURVEY LANDFILL SITES

AREA LF-01

DATE	JOB NO	SCALE	DRW DW	SHT 6
APR. '84	84112	1" = 300'	CHK CA	OF 6

SCANLON & ASSOCIATES

SURVEY CERTIFICATE

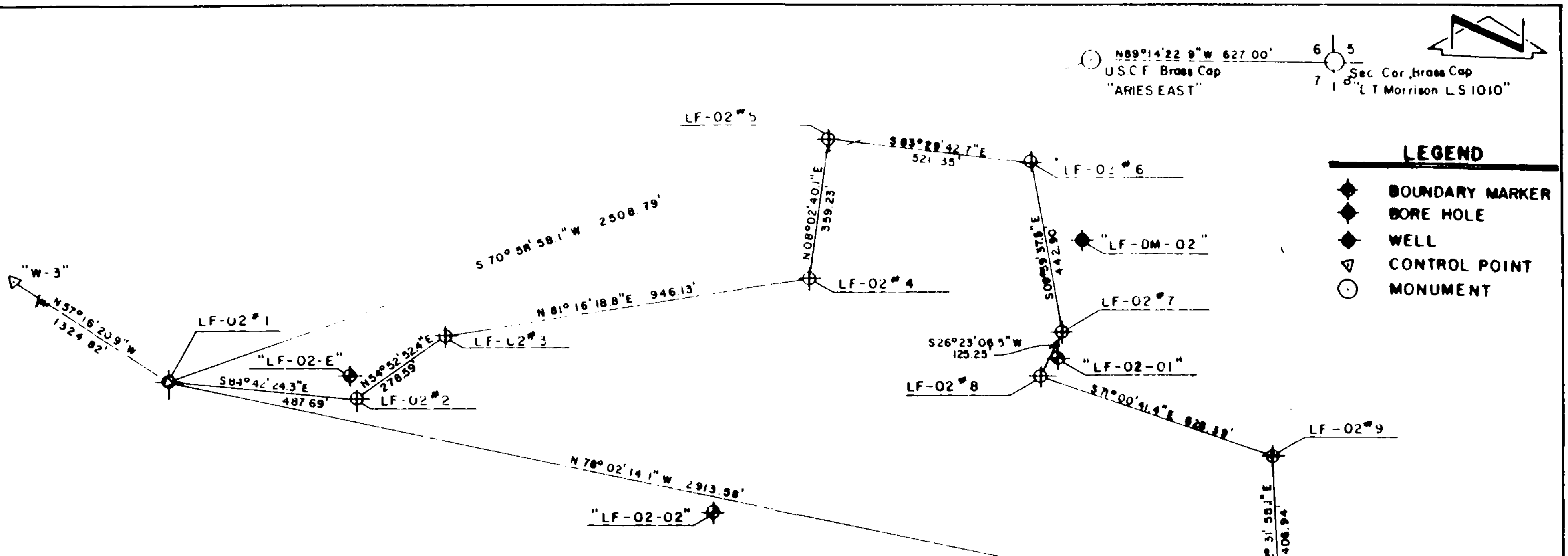
I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL FIELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

THOMAS H. WAGNER N.M.P.L.S. NO. 3517

DATE

THOMAS H. WAGNER NEW MEXICO 3517 REGISTERED PROFESSIONAL

PLEASE NOTE: The southern limit of landfill 02 coincides with the north bank of active channel of Tijeras Arroyo, and was not surveyed.



LEGEND

- BOUNDARY MARKER
- BORE HOLE
- WELL
- CONTROL POINT
- MONUMENT

	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL	Sec Cor 6/5 7/8	410041.64	1465902.48	
	"Aries East"	409414.70	1465910.80	5310.31
BOUNDARY MARKERS	LF-02 #1	407042.83	1465093.31	5243.74
	LF-02 #2	407528.45	1465048.31	5250.70
	LF-02 #3	407756.32	1465208.58	5252.40
	LF-02 #4	408691.50	1465352.15	5264.83
	LF-02 #5	408741.77	1465707.84	5274.51
	LF-02 #6	409259.77	1465648.78	5278.11
	LF-02 #7	409336.63	1465212 60	5271.15
	LF-02 #8	409280.97	1465100 40	5269.94
	LF-02 #9	409875.16	1464895.94	5276.12
	LF-02 #10	409893.14	1464489.39	5270.76
BORE HOLES	"LF-02-01"	409324.27	1465146.57	5271.46
	"LF-02-02"	408442.35	1464754.29	5260.07
	"LF-02-E"	407512.88	1465106.49	5250.24
WELL	"LF-DM-02"	409389.02	1465447.12	5282.42

SURVEY CERTIFICATE

I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL FIELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

Thomas H. Wagner — 4/6/84

THOMAS H. WAGNER N.M.P.L.S. NO. 5517 — DATE

THOMAS H. WAGNER NEW MEXICO 5517 REGISTERED PROFESSIONAL LAND SURVEYOR

SCIENCE APPLICATIONS INC.

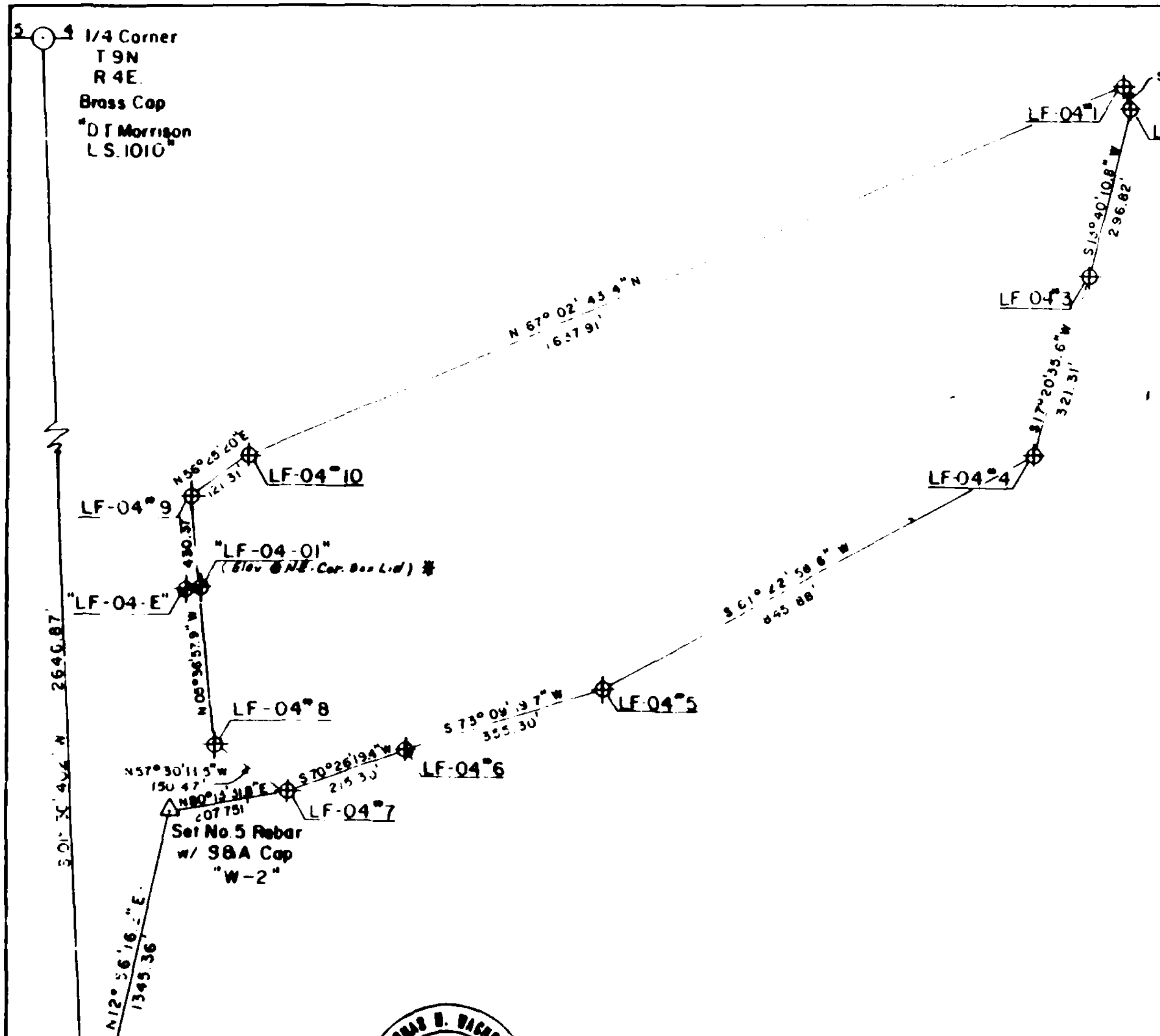
KAFB SURVEY LANDFILL SITES

AREA LF-02

DATE	JOB NO	SCALE	DRW DW	SHT 4
APR. '84	84112	1" = 250'	CHK CA	OF 6

SCANLON & ASSOCIATES

PLEASE NOTE: The northern landfill 04 coincides with the southern fenceline of the active KAFB landfill (LF-06), and was not surveyed.



	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL	1/4 Cor. 5-4	415405.45	1468391.26	5348.318
	Sec Cor 5-4/8-9	415331.03	1465745.44	5387.517
	W-2"	415692.25	1467056.65	5375.728
BOUNDARY MARKERS	LF-04#1	417277.24	1468306.94	5435.21
	LF-04#2	417288.42	1468267.32	5435.96
	LF-04#3	417218.27	1467978.90	5430.41
	LF-04#4	417122.46	1467672.10	5425.77
	LF-04#5	416379.91	1467266.96	5414.75
	LF-04#6	416039.86	1467164.01	5405.67
	LF-04#7	415836.98	1467091.92	5383.73
	LF-04#8	415710.08	1467172.76	5360.85
	LF-04#9	415667.96	1467601.06	5358.06
	LF-04#10	415769.03	1467668.15	5385.20
BORE HOLES	"LF-04-01"	415685.21	1467445.49	*5354.23
	"LF-04-E"	415658.81	1467440.43	5350.56

SURVEY CERTIFICATE

I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL FIELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

THOMAS H. WAGNER N.M.P.L.S. NO. 3517 — DATE

THOMAS H. WAGNER NEW MEXICO 3517 REGISTERED PROFESSIONAL LAND SURVEYOR

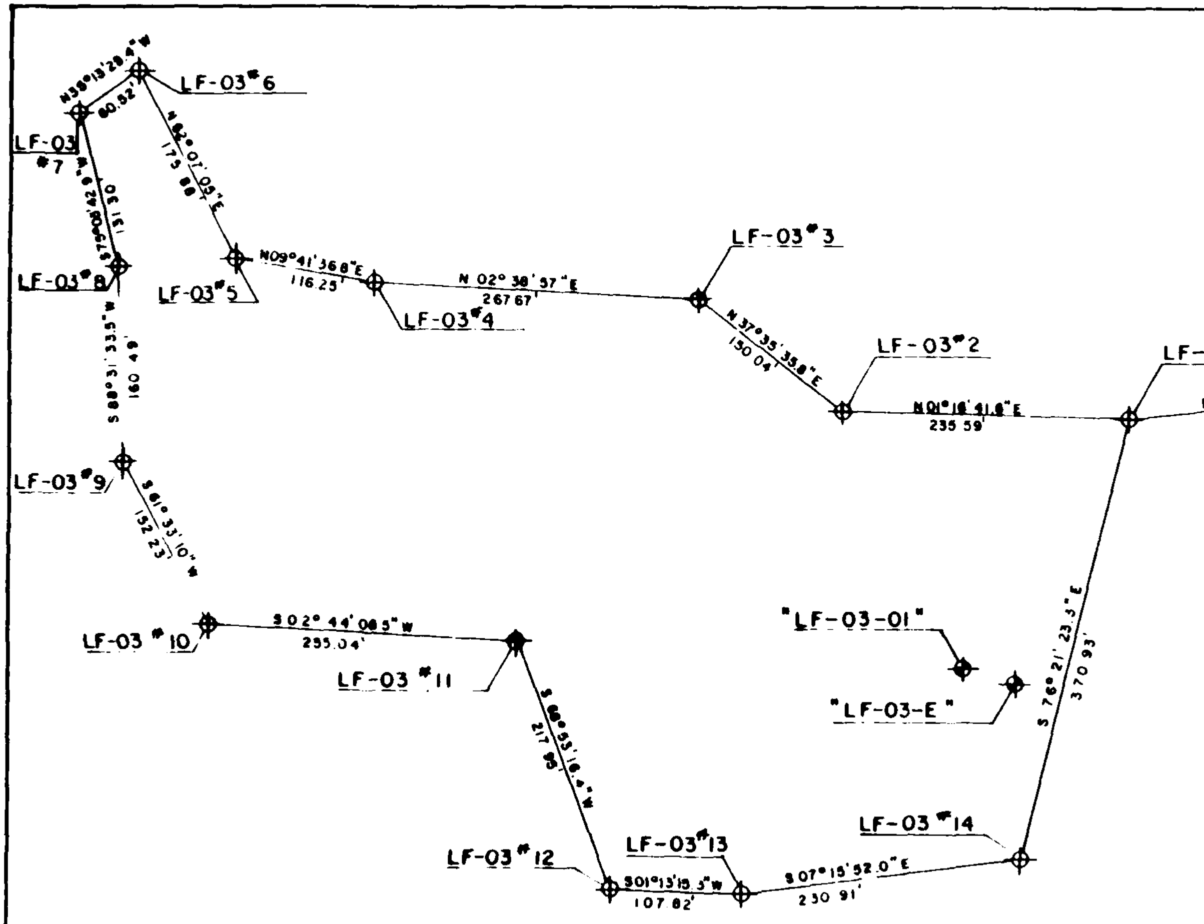
SCIENCE APPLICATIONS INC.

KAFB SURVEY LANDFILL SITES

AREA LF-04

DATE	JOB NO	SCALE	DRW	SHT
MAR. '84	84112	1"=200'	CHK CA	2 OF 6

SCANLON & ASSOCIATES



	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL	"W-3"	405928.39	1465809.56	5245.522
BOUNDARY MARKERS	LF-03#1	405902.85	1466045.95	5231.393
	LF-03#2	405907.51	1466281.48	5269.638
	LF-03#3	405999.04	1466400.37	5269.158
	LF-03#4	406011.41	1466667.75	5316.616
	LF-03#5	406030.98	1466782.34	5321.668
	LF-03#6	406186.44	1466864.59	5330.473
	LF-03#7	406151.54	1466914.03	5331.047
	LF-03#8	406024.67	1466880.19	5329.322
	LF-03#9	405864.89	1466876.06	5327.443
	LF-03#10	405730.38	1466803.55	5317.756
	LF-03#11	405718.81	1466548.80	5273.144
	LF-03#12	405514.89	1466470.29	5266.991
	LF-03#13	405512.59	1466362.50	5269.724
	LF-03#14	405541.79	1466133.44	5237.249
BORE HOLES	"LF-03-01"	405697.72	1466181.46	5240.608
	"LF-03-E"	405685.55	1466138.79	5236.694

SCIENCE APPLICATIONS INC.

KAFB SURVEY LANDFILL SITES

AREA LF-03

DATE	JOB NO	SCALE	DRW DW	SHT 5
APR. '84	84112	1"=100'	CHK CA	OF 6

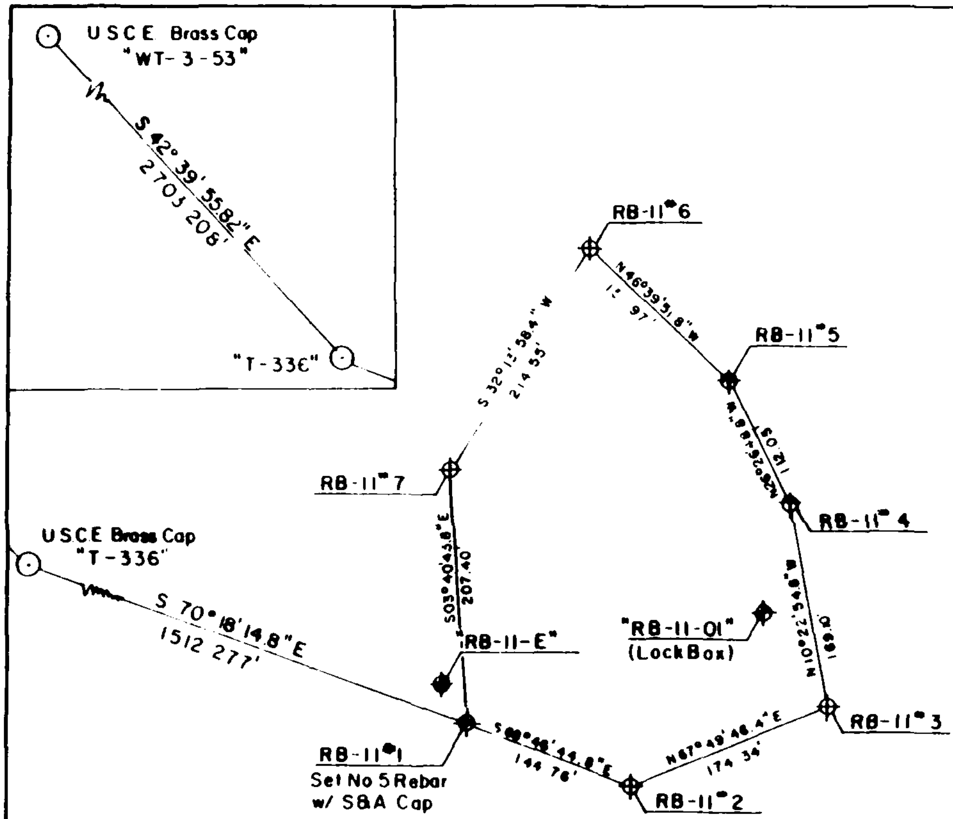
SCANLON & ASSOCIATES

SURVEY CERTIFICATE

I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL FIELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

THOMAS H. WAGNER N.M.P.L.S. NO. 3517 — DATE

THOMAS H. WAGNER NEW MEXICO 3517 REGISTERED PROFESSIONAL LAND SURVEYOR



LEGEND

- BOUNDARY MARKER
- BORE HOLE
- WELL
- CONTROL POINT
- MONUMENT

	SURVEY POINT	COORDINATES X	COORDINATES Y	ELEVATION
CONTROL *	"T-336"	418280.38	1458346.83	5439.126
BOUNDARY MARKERS	RB-11 #1	419704.38	1457837.15	5455.001
	RB-11 #2	419839.83	1457784.75	5458.015
	RB-11 #3	420000.78	1457850.54	5459.095
	RB-11 #4	419970.31	1458016.87	5457.136
	RB-11 #5	419920.40	1458117.19	5455.348
	RB-11 #6	419805.50	1458225.61	5451.809
	RB-11 #7	419691.07	1458044.12	5453.302
BORE HOLES	"RB-11-E"	419683.32	1457869.09	5454.135
	"RB-11-01"	419948.62	1457927.10	5458.206
*	"WT-3-53"	416448.57	1460334.56	5402.834

SCIENCE APPLICATIONS INC.

KAFB SURVEY LANDFILL SITES

AREA RB-11

DATE	JOB NO	SCALE	DRW DHW	SHT 3
MAR. '84	84112	1"=100'	CHK CA	OF 6

SCANLON & ASSOCIATES

SURVEY CERTIFICATE

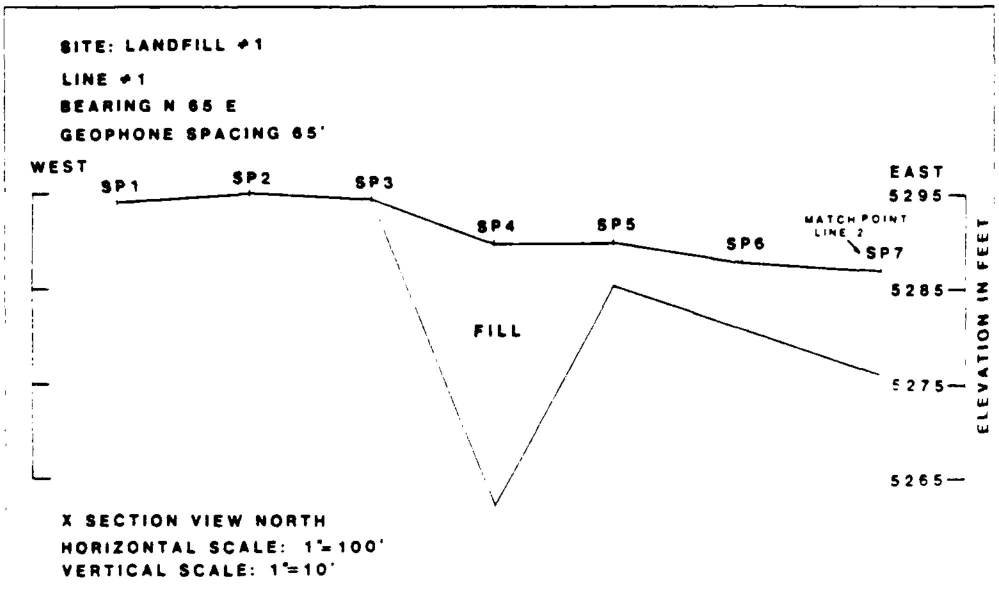
I, THOMAS H. WAGNER, DULY LICENSED UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT WAS PREPARED UNDER MY SUPERVISION FROM ACTUAL IELD NOTES, AND IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

THOMAS H. WAGNER N.M.P.L.S. NO. 3517   3/28/84 DATE

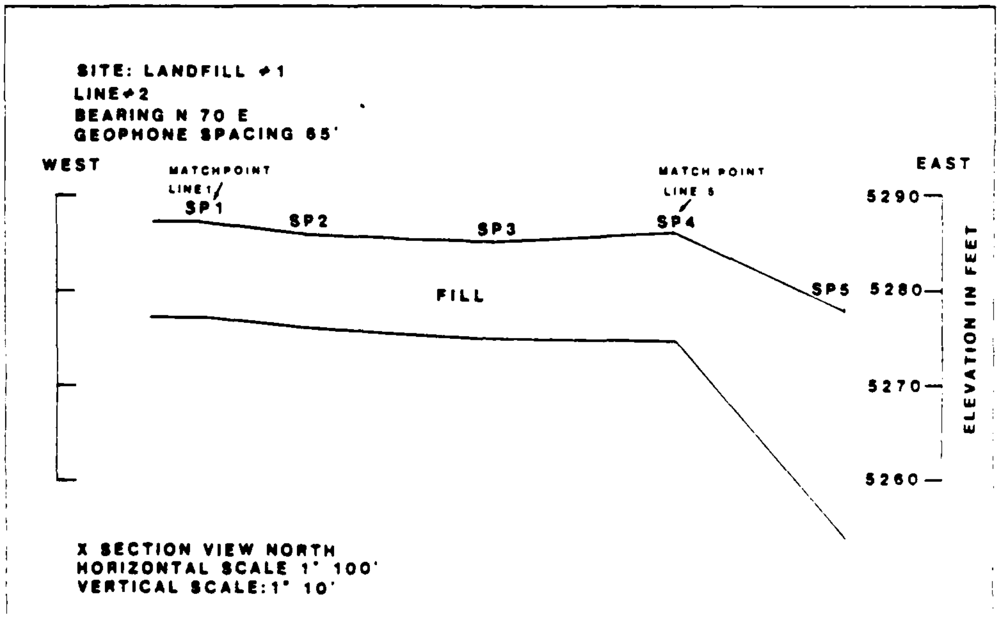
APPENDIX I

SUMMARY OF
FM FOX AND ASSOCIATES
DATA

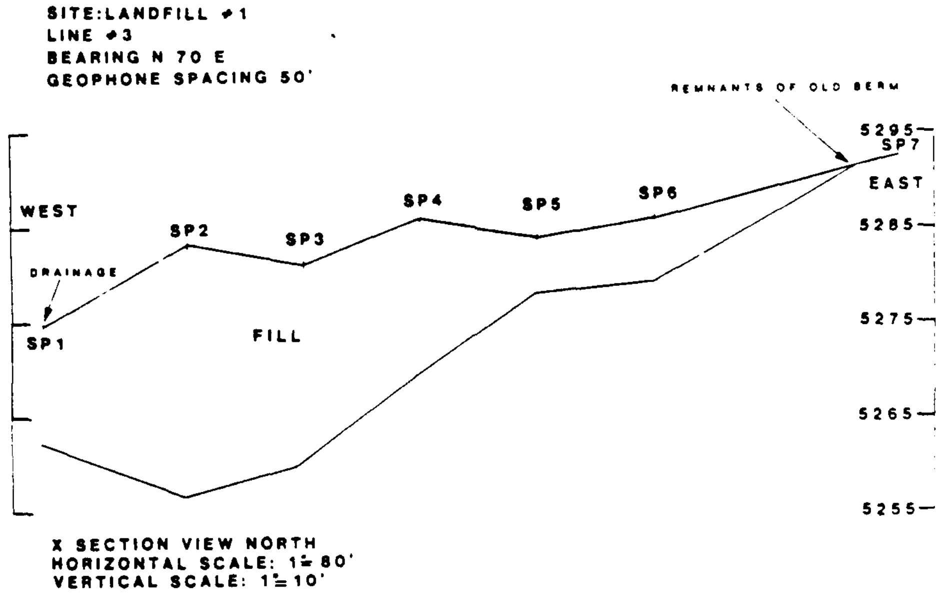
NOTE: All seismic refraction data plots have been reduced to 50% of original size, with a corresponding reduction of the indicated scales.



SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13, 1984
	Figure 5



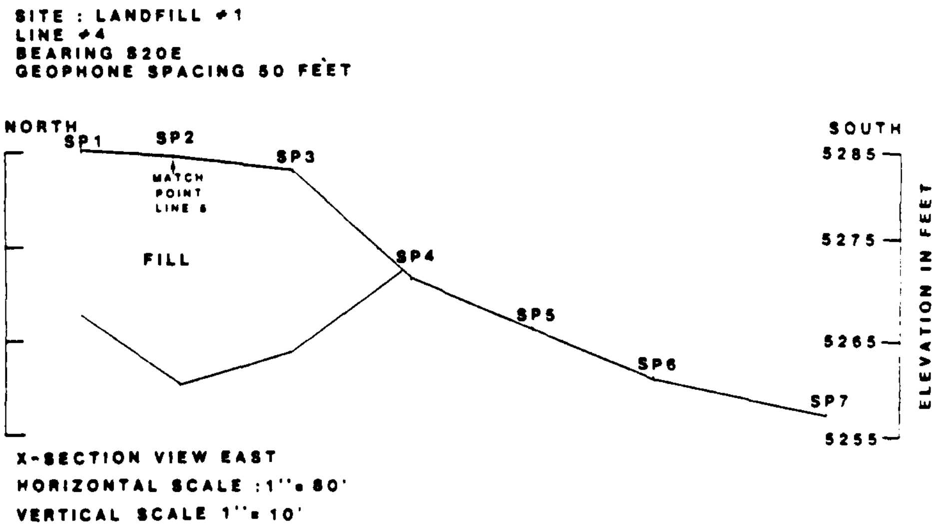
SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13, 1984
	Figure 6



SEISMIC SURVEY CROSS SECTION

FOX Consulting Engineers and Geologists

Job No 011121
Date JUNE 13,1984
Figure 7

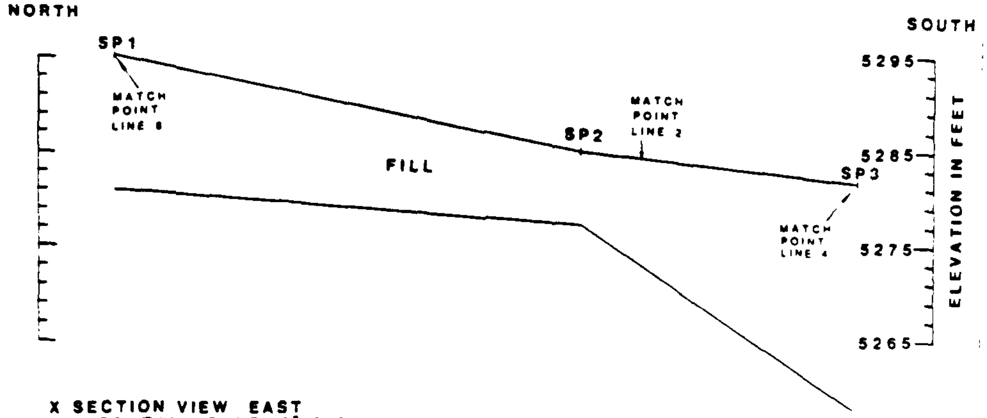


SEISMIC SURVEY CROSS SECTION

FOX Consulting Engineers and Geologists

Job No 0111210
Date JUNE 13,1984
Figure 8

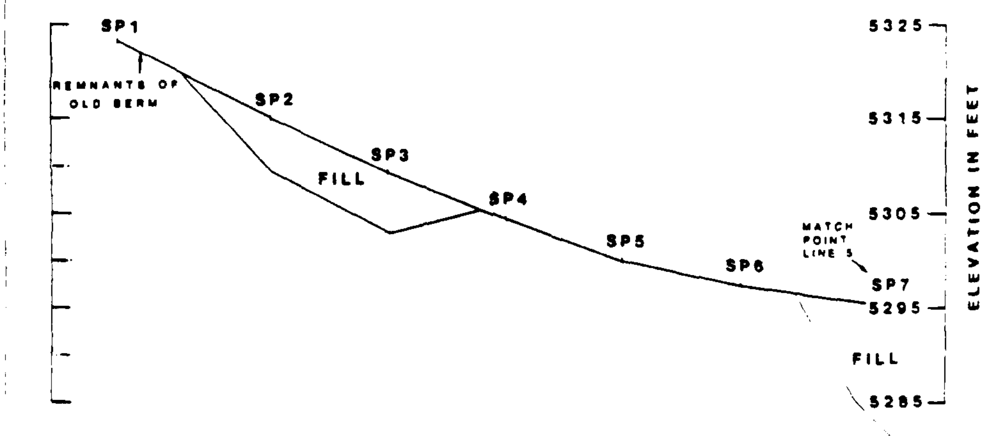
SITE: LANDFILL #1
LINE #5
BEARING S20E
GEOPHONE SPACING 50'



X SECTION VIEW EAST
HORIZONTAL SCALE: 1" 80'
VERTICAL SCALE: 1" 80'

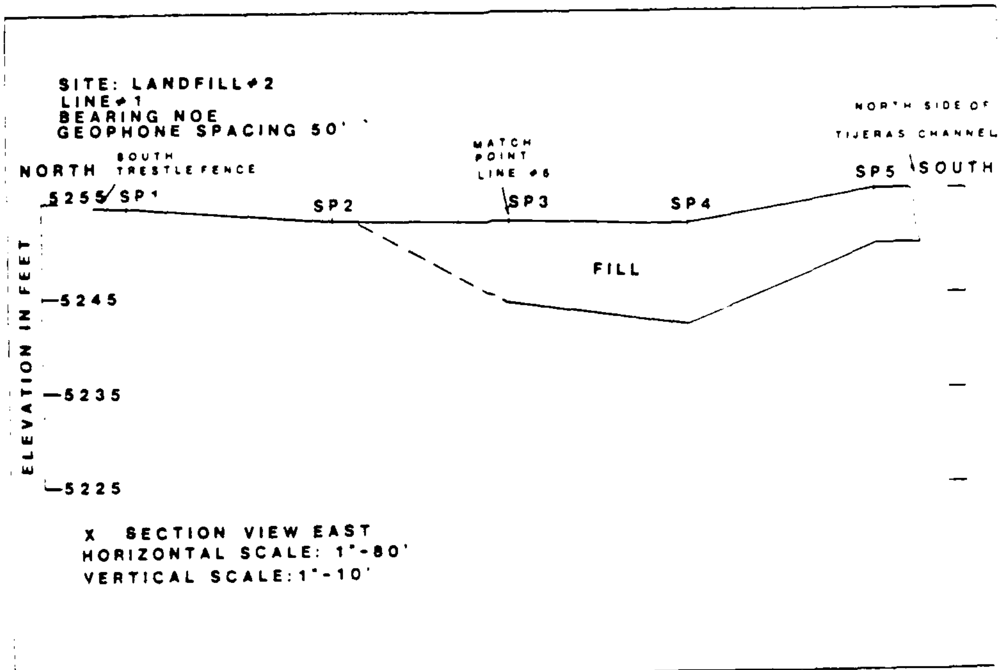
SEISMIC SURVEY CROSS SECTION	Job No	0111210
FOX Consulting Engineers and Geologists	Date	JUNE 13,1984
	Figure	9

SITE: LANDFILL #1
LINE #6
BEARING S 20E
GEOPHONE SPACING 50'

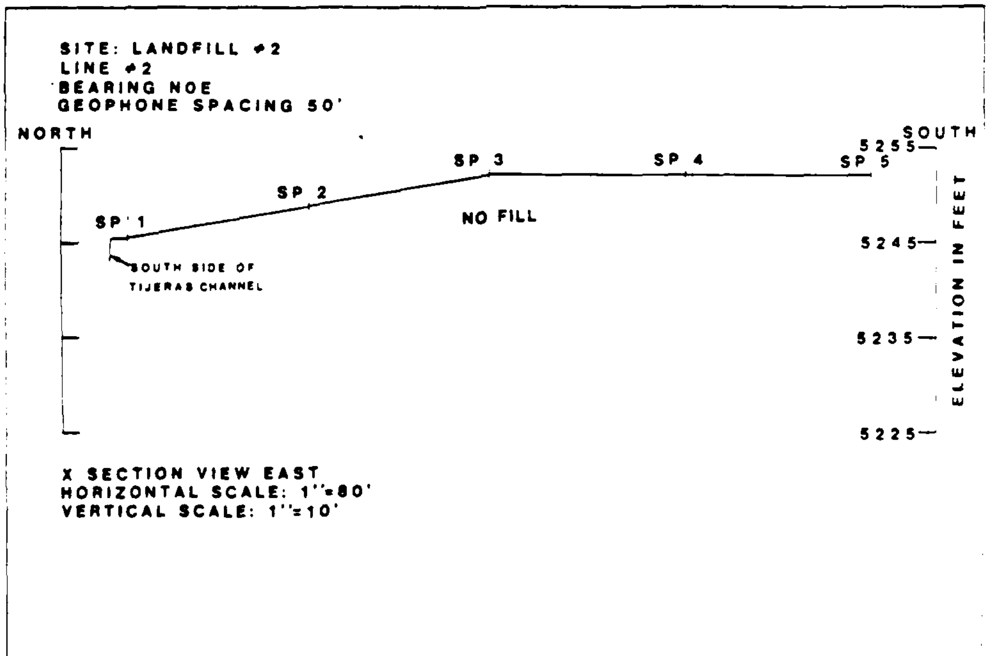


CROSSECTION VIEW EAST
HORIZONTAL SCALE: 1"=80'
VERTICAL SCALE: 1"=10'

SEISMIC SURVEY CROSS SECTION	Job No	0111210
FOX Consulting Engineers and Geologists	Date	JUNE 13,1984
	Figure	10

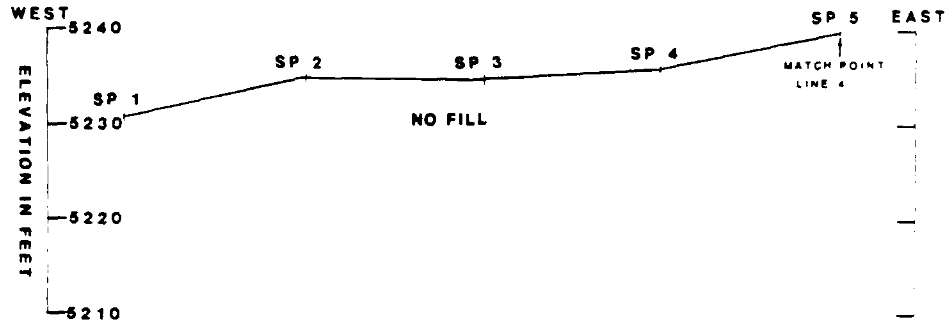


SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13, 1984
	Figure 11



SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13, 1984
	Figure 12

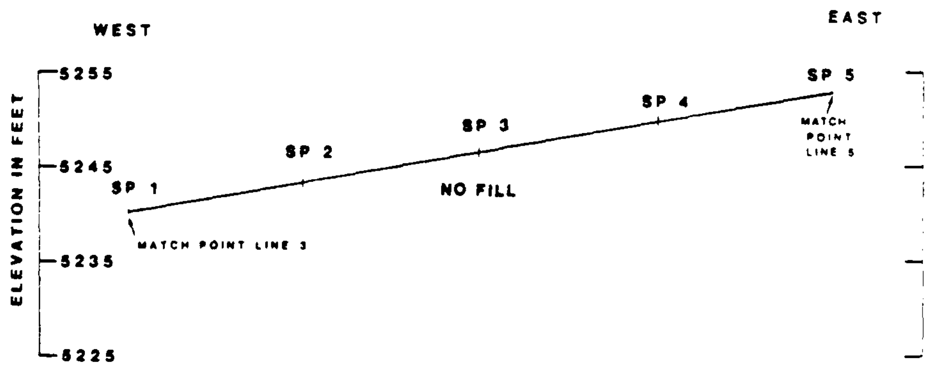
SITE: LANDFILL #2
LINE #3
BEARING N77W
GEOPHONE SPACING 50'



X SECTION VIEW NORTH
HORIZONTAL SCALE: 1"=80'
VERTICAL SCALE: 1"=10'

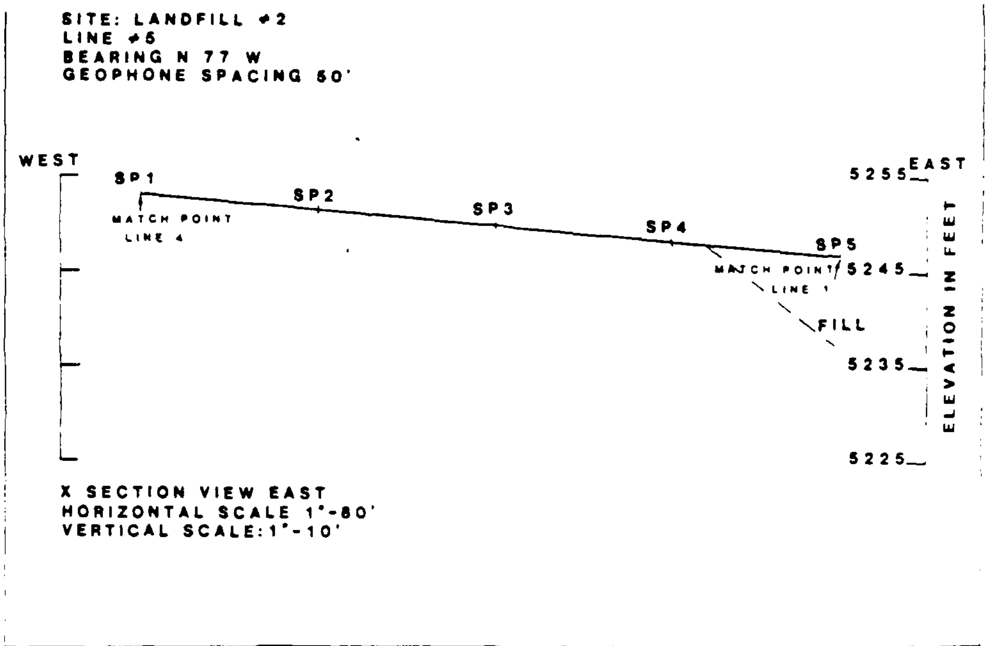
SEISMIC SURVEY CROSS SECTION	Job No	0111210
FOX Consulting Engineers and Geologists	Date	JUNE 1,1984
	Figure	13

SITE: LANDFILL #2
LINE #4
BEARING N77W
GEOPHONE SPACING 50'



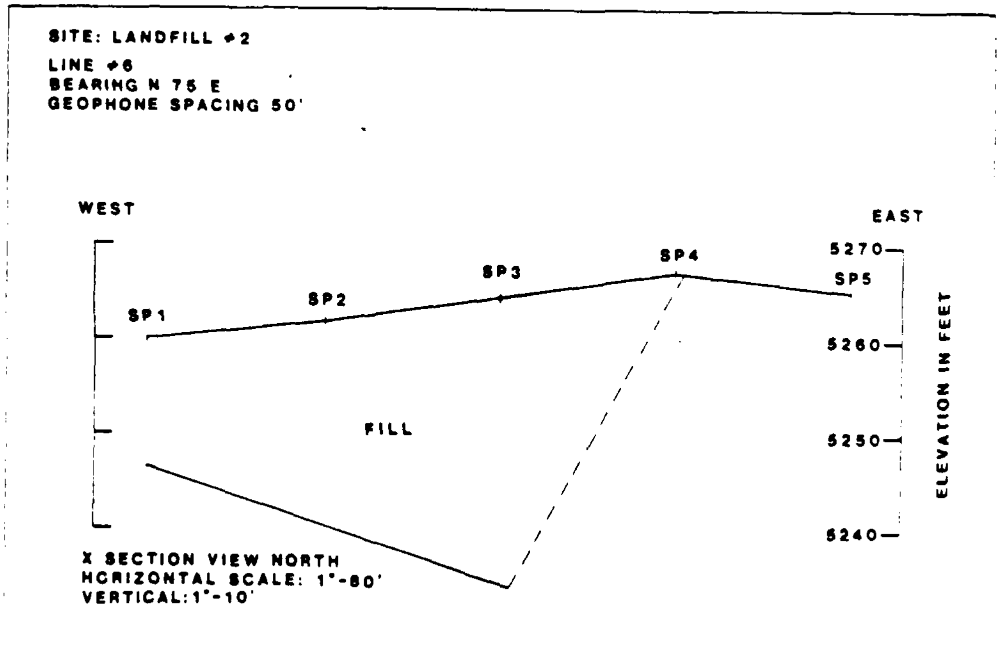
XSECTION VIEW NORTH

SEISMIC SURVEY CROSS SECTION	Job No	0111210
FOX Consulting Engineers and Geologists	Date	JUNE 13,1984
	Figure	14



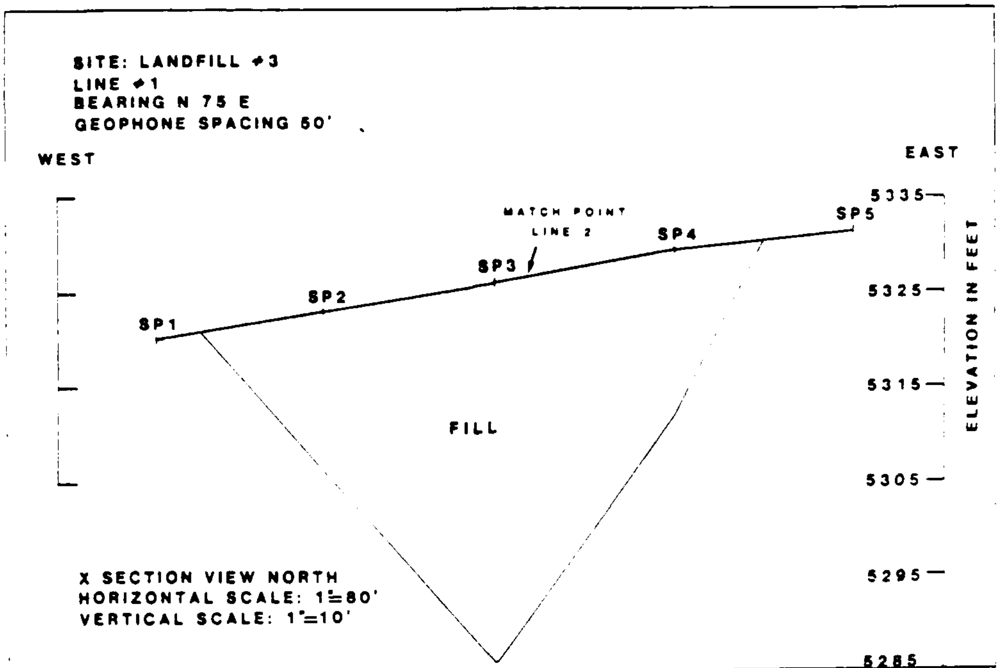
SEISMIC SURVEY CROSS SECTION
FOX Consulting Engineers and Geologists

Job No 0111210
Date JUNE 13,1984
Figure 15

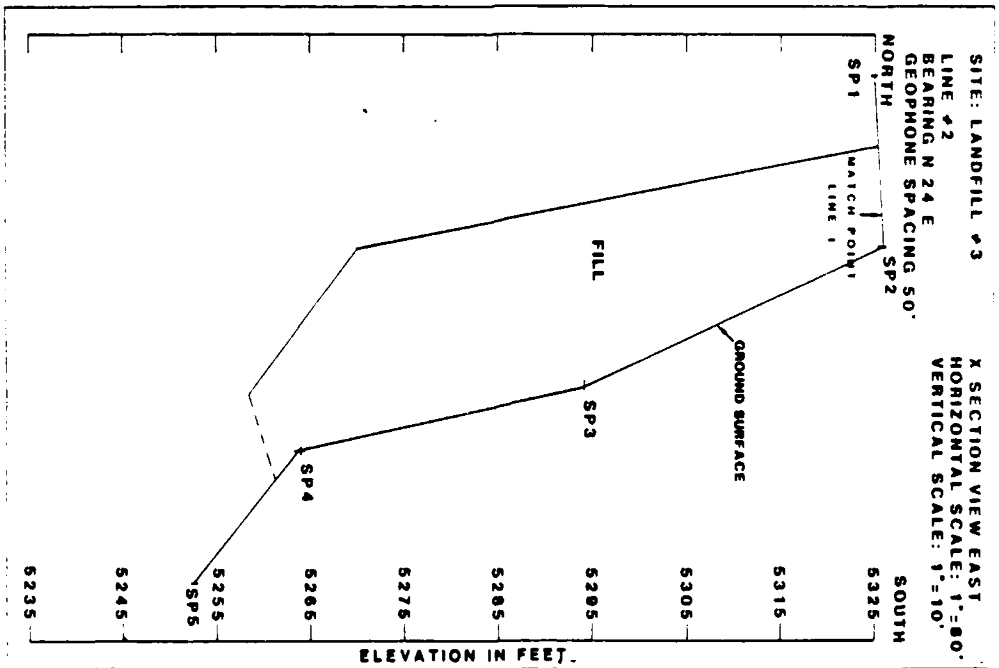


SEISMIC SURVEY CROSS SECTION
FOX Consulting Engineers and Geologists

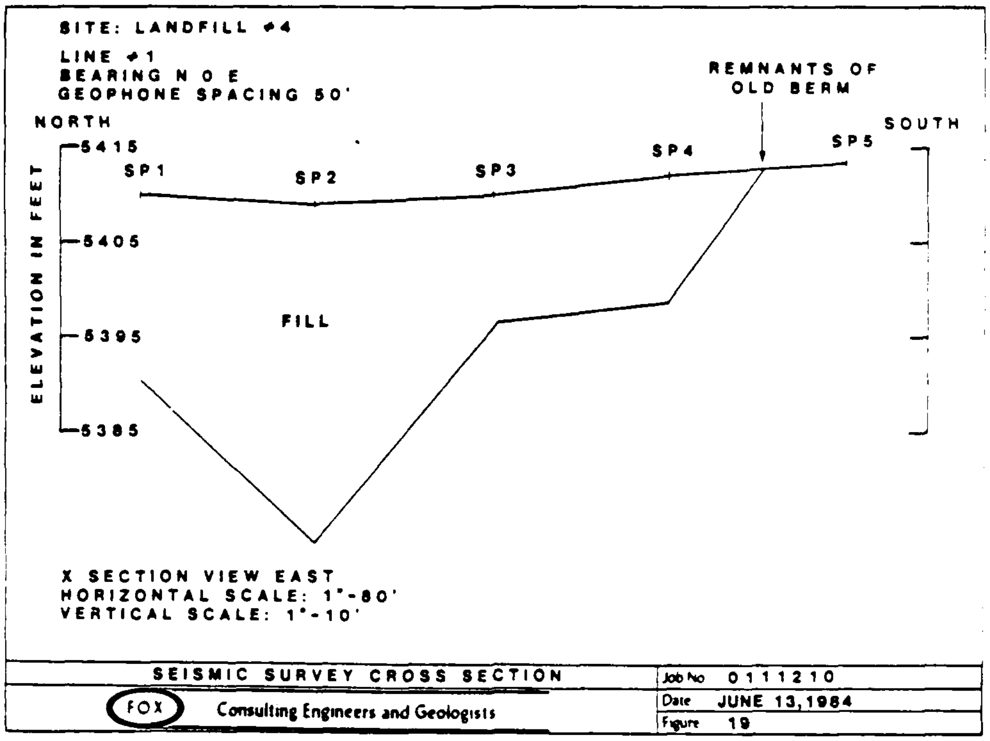
Job No 0111210
Date JUNE 13,1984
Figure 16

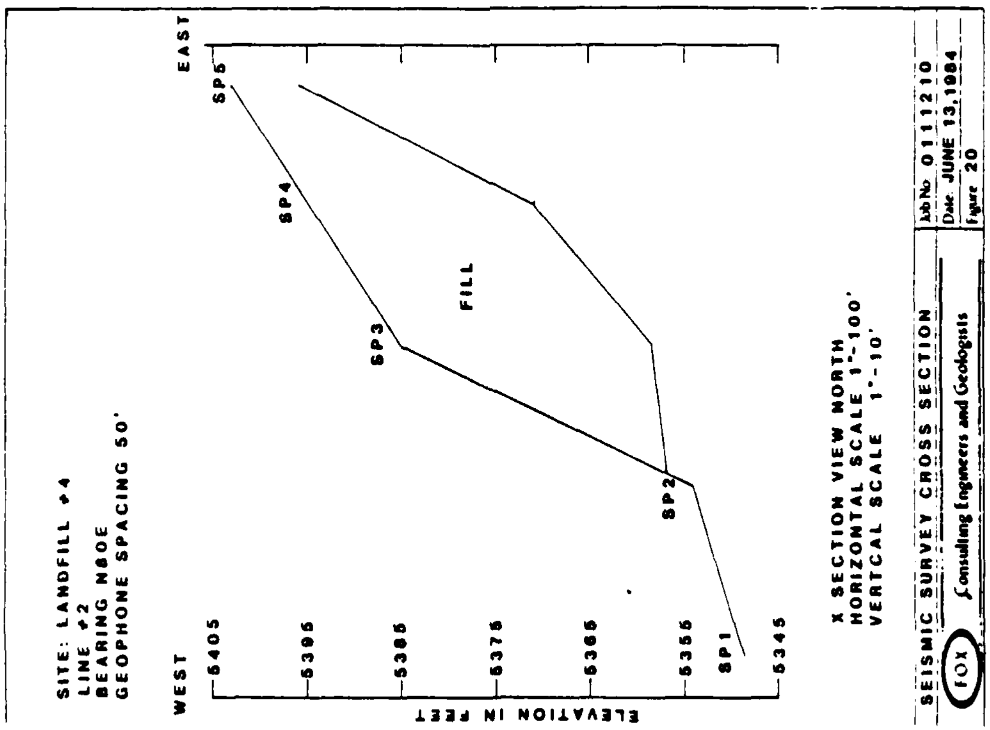


SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 17



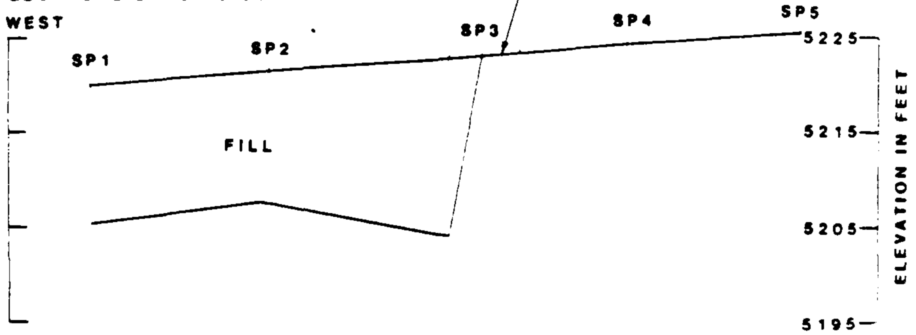
SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 18


SITE: LANDFILL #4
LINE #1
BEARING N 0 E
GEOPHONE SPACING 50'
REMNANTS OF OLD BERM
NORTH
SOUTH
SP1
SP2
SP3
SP4
SP5
ELEVATION IN FEET
5415
5405
5395
5385
FILL
X SECTION VIEW EAST
HORIZONTAL SCALE: 1"-80'
VERTICAL SCALE: 1"-10'
SEISMIC SURVEY CROSS SECTION
FOX Consulting Engineers and Geologists
Job No 011210
Date JUNE 13,1984
Figure 19


SITE: LANDFILL #4
LINE #2
BEARING N60E
GEOPHONE SPACING 50'
WEST
EAST
SP1
SP2
SP3
SP4
SP5
ELEVATION IN FEET
5405
5395
5385
5375
5365
5355
5345
FILL
X SECTION VIEW NORTH
HORIZONTAL SCALE 1"-100'
VERTCAL SCALE 1"-10'
SEISMIC SURVEY CROSS SECTION
FOX Consulting Engineers and Geologists
Job No 011210
Date JUNE 13,1984
Figure 20

SITE:LANDFILL #4

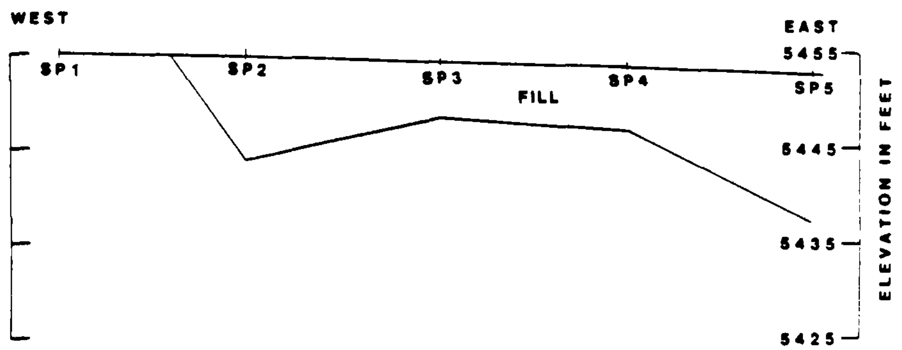
LINE #3
BEARING N 50 E
GEOPHONE SPACING 50'



X SECTION VIEW NORTH
HORIZONTAL SCALE: 1"=50'
VERTICAL SCALE: 1"=10'

SEISMIC SURVEY CROSS SECTION	Job No. 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 21

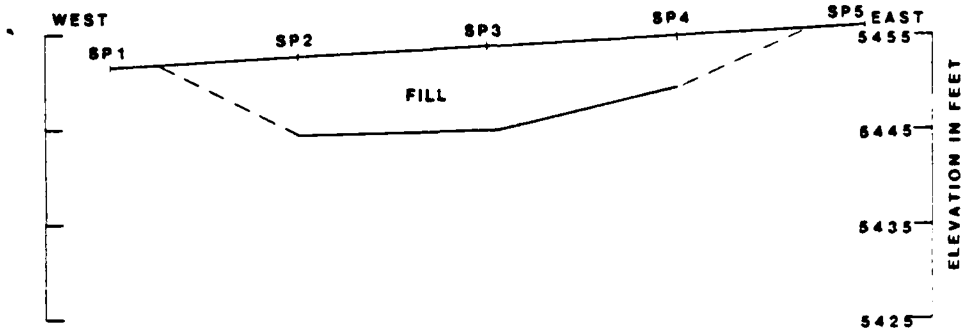
SITE:RB-11
LINE #1
BEARING N 86 E
GEOPHONE SPACING 20'



X SECTION VIEW NORTH
HORIZONTAL SCALE:1"=30'
VERTICAL SCALE: 1"=10'

SEISMIC SURVEY CROSS SECTION	Job No. 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 22

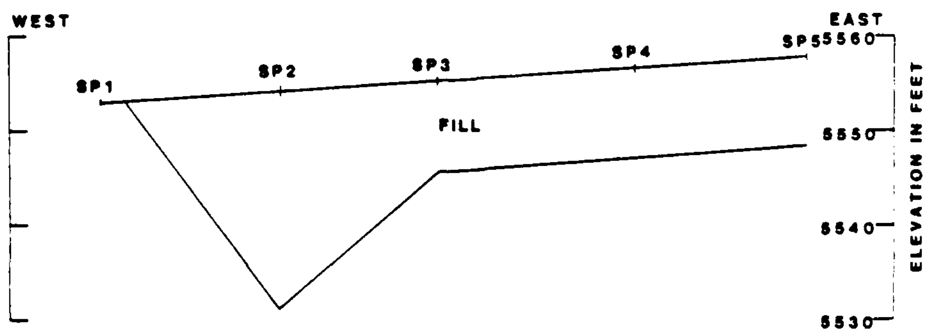
SITE: RB-11
LINE #2
BEARING N 82 W
GEOPHONE SPACING 20'



X SECTION VIEW NORTH
HORIZONTAL SCALE: 1"=30'
VERTICAL SCALE: 1"=10'

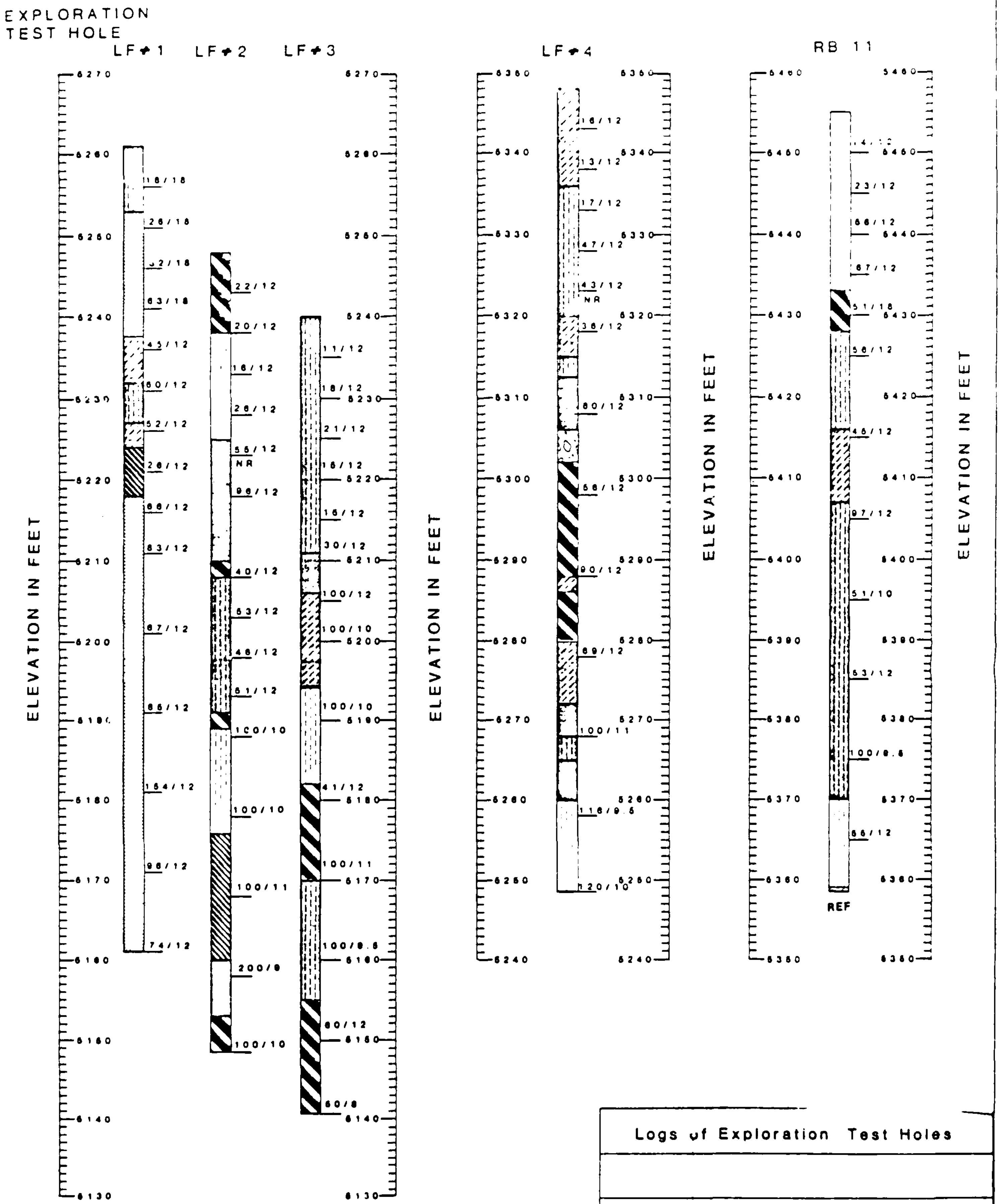
SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 23

SITE:RB-11
LINE #3
BEARING N 73 W
GEOPHONE SPACING 25'



X SECTION VIEW NORTH
HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=10'

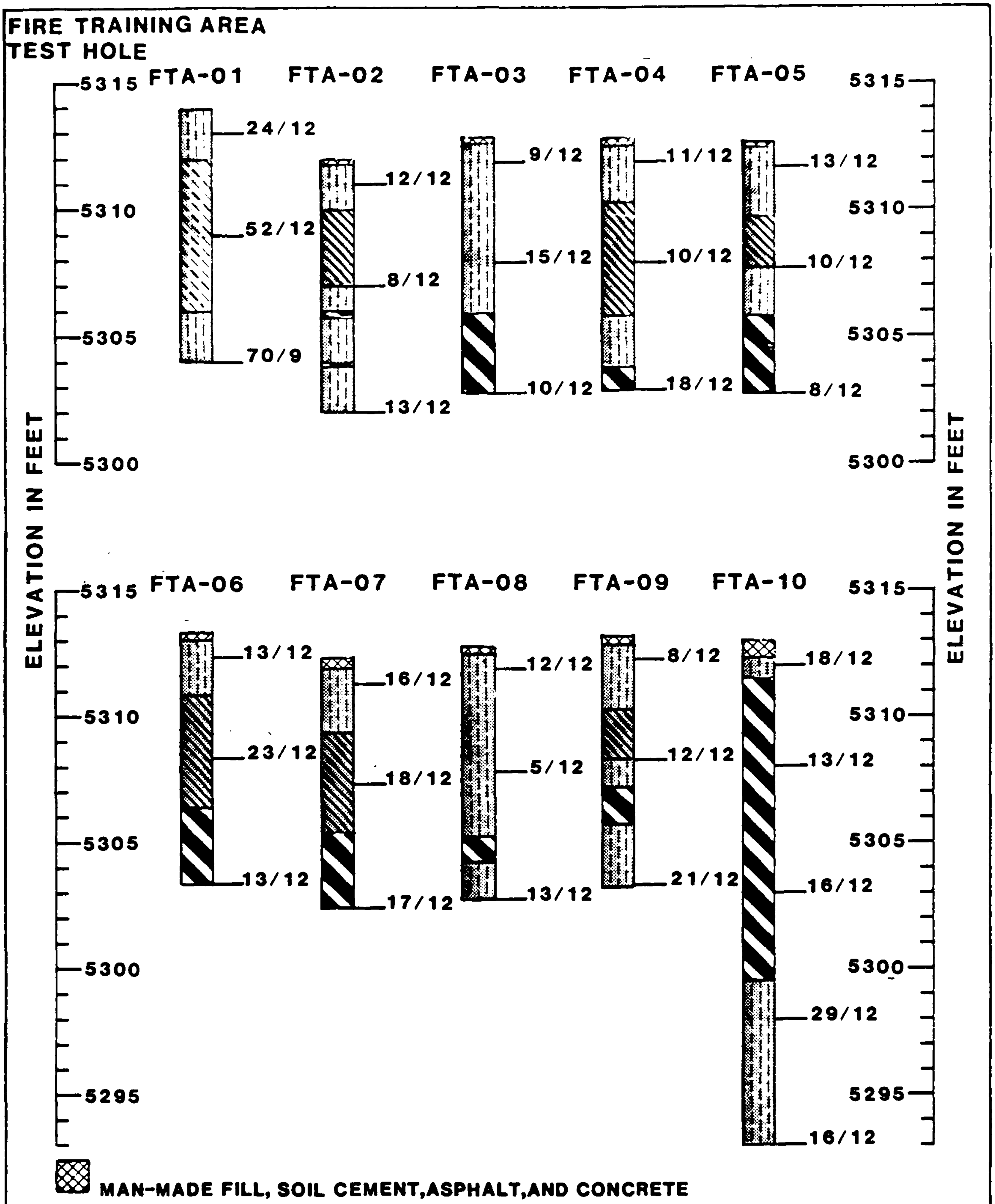
SEISMIC SURVEY CROSS SECTION	Job No 0111210
FOX Consulting Engineers and Geologists	Date JUNE 13,1984
	Figure 24



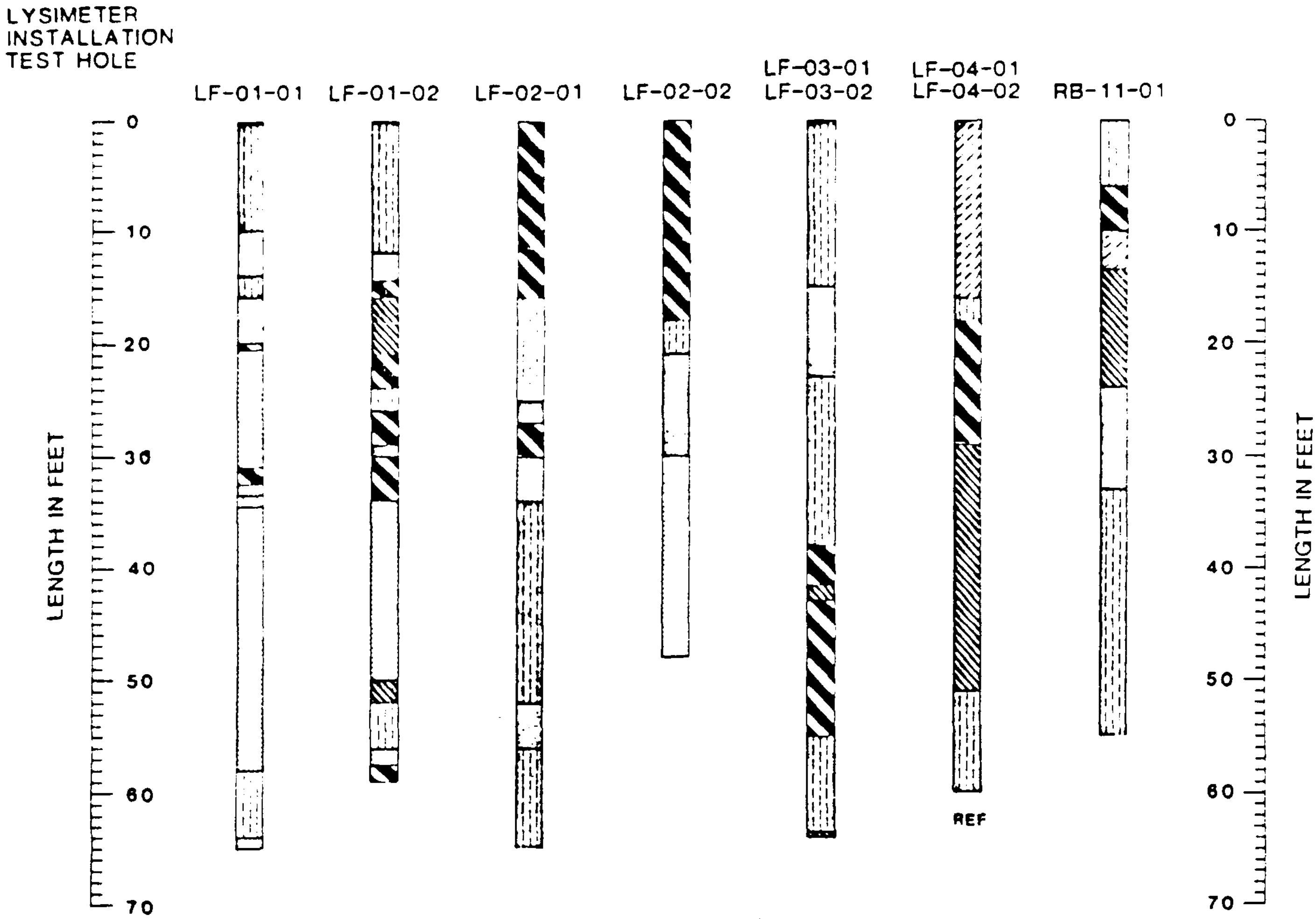
Logs of Exploration Test Holes

FOX Consulting Engineers and Geologists

Date July 1, 1983	Logs of Exploration Test Holes
Drawn By BD	
Reviewed By BB	
Job No 0111210	Figure 26



LOGS OF FIRE TRAINING AREA TEST HOLES	Job No: **0111210**
FOX Consulting Engineers and Geologists I-13	Date: **JUNE 13,1984**
	Figure **25**



LOGS OF LYSIMETER

INSTALLATION TEST HOLES

FOX Consulting Engineers and Geologists

Date: JUNE 13, 1984 Drawn By: SB Reviewed By: MDV	LOGS OF LYSIMETER INSTALLATION TEST HOLES
Job No: 0111210	Figure 27

LEGEND

SAND, coarse to fine-grained, silty, trace gravel, medium dense to dense, slightly moist to moist, some calcareous, light brown to brown (SM)

SAND, medium to fine-grained, clean to slightly silty, trace gravel, loose to medium dense to dense, slightly moist to moist, light brown to brown (SP, SW)

SAND, very silty to SILT, very sandy, fine-grained, loose to medium dense, some calcareous, slightly moist to moist, brown (SM-ML)

SAND, fine-grained, very clayey to CLAY, very sandy, some trace gravel, medium dense to dense, medium moist to very moist, calcareous, light brown to brown (SC-CL)

CLAY, soft to stiff to hard, dry to moist, brown, gray (CL)

SILT, fine-grained, slightly sandy, very stiff to hard, slightly calcareous to calcareous, slightly moist to moist, light brown (ML)

SAND, medium to fine-grained, slightly silty to clean, medium dense to dense, dry to slightly moist, light brown to brown (SP-SM, SW-SM)

SAND AND GRAVEL, medium to fine-grained, silty, dense, dry to slightly moist, gray-brown (SM-GM)

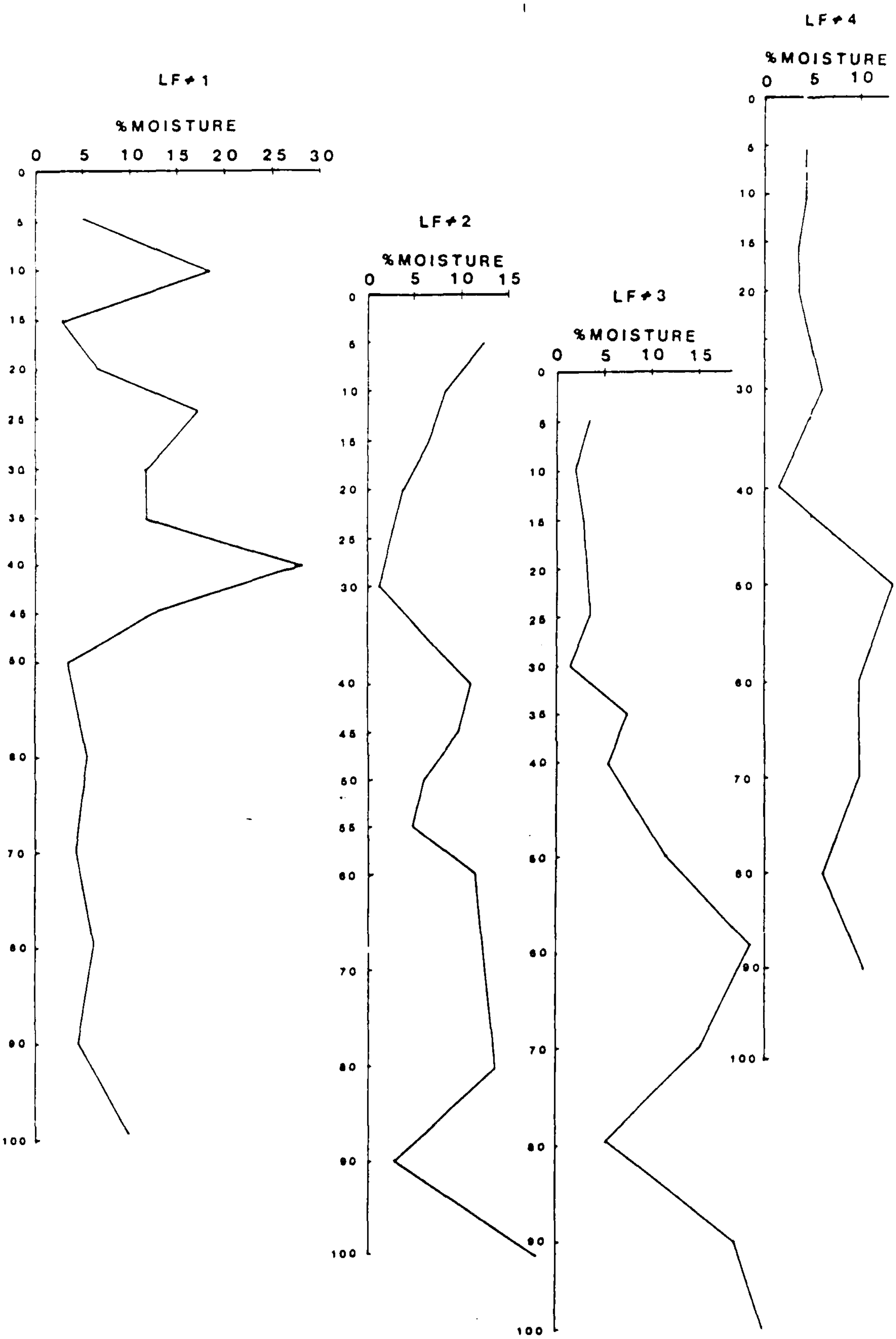
REF indicates refusal to auger drilling

NR indicates no sample recovery

NOTES

1. Test holes were drilled on May 31, 1983 to June 6, 1983 with a 6-inch diameter hollowstem continuous flight power auger.
2. (18/18) location of Standard Penetration Test; indicates that 18 blows with a 140-pound hammer, falling 30 inches, were required to drive a 2-inch sampler 18 inches.
3. The location of borings were approximately determined by tape and compass measurement. Elevations of borings are approximately determined by interpolation between plan contours. The location and elevation of the borings should be considered accurate only to the degree implied by the method used.
4. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
5. Neither bedrock nor groundwater was encountered in the test holes.

LOGS OF TEST HOLES	Job No: 0111210
FOX Consulting Engineers and Geologists I-15	Date: June 30, 1983
	Figure 28



MOISTURE CONTENT vs. DEPTH

FOX Consulting Engineers and Geologists

Date JUNE 13,1984	
Drawn By MS	
Reviewed By SB	
Job No 0111210	Figure 29

SUMMARY OF LABORATORY TEST DATA

LF#1

TEST HOLE	DEPTH OF SAMPLE (ft)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS		Sieve Analysis % Passing					SOIL DESCRIPTION	REMARKS
				LL	PI	No. 4	No. 10	No. 40	No. 80	No. 200		
LF#1	5	108	5.1	-	-	99	98	93	72	20	silty SAND SM	
LF#1	10	84	8.6	-	-	100	97	48	7	3	clean SAND SP	
LF#1	15	95	2.9	-	-	-	-	-	-	-	clean SAND SP	
LF#1	20	78	6.6	-	-	-	-	-	-	-	clean SAND SP	
LF#1	25	104	17.2	22	NP	-	-	-	-	-	very silty SAND SM-ML	
LF#1	30	111	11.3	-	-	100	92	54	35	14	silty SAND SM	
LF#1	35	107	11.7	23	NP	-	-	-	-	-	silty SAND SM	
LF#1	40	99	27.0	-	-	100	99	94	83	56	very sandy CLAY SC-CL	
LF#1	45	94	12.3	-	-	100	100	96	70	7	clean SAND SP	
LF#1	50	92	3.5	-	-	99	98	72	12	1	clean SAND SP	
LF#1	60	92	5.5	-	-	-	-	-	-	-	clean SAND SP	
LF#1	70	106	4.1	-	-	91	73	25	6	2	clean SAND SP	
LF#1	80	110	6.2	-	-	86	65	29	7	3	clean SAND SP	
LF#1	90	100	4.4	-	-	-	-	-	-	-	clean SAND SP	
LF#1	100	95	10.0	-	-	-	-	-	-	-	clean SAND SP	

SUMMARY OF LABORATORY TEST DATA

LF#2

TEST HOLE	DEPTH OF SAMPLE (ft)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS		Sieve Analysis % Passing					SOIL DESCRIPTION	REMARKS
				LL	PI	No. 4	No. 10	No. 40	No. 80	No. 200		
LF#2	5	85	12.5	-	-	100	100	98	88	65	very sandy CLAY CL	
LF#2	10	73	8.3	-	-	-	-	-	-	-	sandy SILT ML	
LF#2	15	77	6.7	-	-	100	100	98	96	91	SILT ML	
LF#2	20	104	3.8	-	-	-	-	-	-	-	SILT ML	
LF#2	30	110	1.1	-	-	100	73	19	10	5	slightly silty SAND SP-SM	
LF#2	40	97	11.0	23	NP	-	-	-	-	-	SILT ML	
LF#2	45	106	9.7	28	5	-	-	-	-	-	SILT ML	
LF#2	50	104	6.1	21	NP	-	-	-	-	-	SILT ML	
LF#2	55	103	5.3	NV	NP	-	-	-	-	-	SILT ML	
LF#2	60	118	11.4	NV	NP	-	-	-	-	-	SILT ML	
LF#2	70	102	12.5	26	NP	-	-	-	-	-	SILT ML	
LF#2	80	124	13.3	-	-	98	92	81	77	43	very clayey SAND SC-CL	
LF#2	90	123	2.9	-	-	99	81	50	34	8	slightly silty SAND SP-SM	
LF#2	100	114	18.6	41	20	-	-	-	-	-	slightly sandy CLAY	

SU[redacted]Y O[redacted]BOR[redacted]RY [redacted] DA[redacted]

LF#3

TEST HOLE	DEPTH OF SAMPLE (ft)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	PI	Sieve Analysis % Passing No. 4	No. 10	No. 40	No. 80	No. 200	SOIL DESCRIPTION	REMARKS
LF#3	5	101	3.6	-	-	96	85	70	60	30	silty SAND SM	
LF#3	10	110	1.9	-	-	78	62	43	35	17	silty SAND SM	
LF#3	15	110	2.7	-	-	95	85	66	55	25	silty SAND SM	
LF#3	20	103	3.1	-	-	-	-	-	-	-	silty SAND SM	
LF#3	25	9.9	3.4	-	-	100	97	92	84	17	silty SAND SM	
LF#3	30	114	1.4	-	-	90	47	25	18	7	slightly silty SAND SP-SM	
LF#3	35	108	7.6	-	-	99	98	95	91	44	very silty SAND SM	
LF#3	40	108	5.4	-	-	-	-	-	-	-	very silty SAND SM	
LF#3	50	98	11.3	26	NP	-	-	-	-	-	slightly sandy SILT	
LF#3	60	101	20.5	54	29	-	-	-	-	-	slightly sandy CLAY	
LF#3	70	104	15.0	-	-	100	99	97	84	34	silty SAND SM	
LF#3	80	111	5.2	-	-	-	-	-	-	-	silty SAND SM	
LF#3	90	108	18.9	34	14	-	-	-	-	-	CLAY	
LF#3	100	104	22.0	-	-	-	-	-	-	-	CLAY	

SUMMARY OF LABORATORY TEST DATA

LF#4

TEST HOLE	DEPTH OF SAMPLE (ft)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS		Sieve Analysis % Passing					SOIL DESCRIPTION	REMARKS
				LL	PI	No. 4	No. 10	No. 40	No. 80	No. 200		
LF#4	5	99	4.2	-	-	100	98	94	88	54	very sandy SILT	
LF#4	10	112	4.2	-	-	-	-	-	-	-	very sandy SILT	
LF#4	15	114	3.5	-	-	-	-	-	-	-	silty SAND	
LF#4	20	110	3.2	-	-	67	48	30	23	14	silty SAND	
LF#4	30	97	6,0	-	-	100	100	96	91	54	very sandy SILT	
LF#4	40	122	1.6	-	-	76	51	28	19	9	slightly to silty SAND SP-SM	
LF#4	50	111	13.3	26	7	-	-	-	-	-	CLAY	
LF#4	60	124	9.8	-	-	99	92	85	80	54	very sandy SILT ML	
LF#4	70	115	14.5	-	-	-	-	-	-	-	very sandy SILT ML	
LF#4	80	101	6.2	-	-	99	91	61	51	33	silty SAND SM	
LF#4	90	101	11.3	-	-	100	100	99	98	75	sandy SILT ML	

SUMMARY OF LABORATORY TEST DATA
RB-11

TEST HOLE	DEPTH OF SAMPLE (FT)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	ATTERBERG LIMITS		Sieve Analysis % Passing					SOIL DESCRIPTION	REMARKS
				LL	PI	No. 4	No. 10	No. 40	No. 80	No. 200		
RB-11	5	94	7.4	-	-	100	100	98	95	76	sandy SILT ML	
RB-11	10	123	1.2	NV	NP	-	-	-	-	-	sandy SILT ML	
RB-11	25	104	9.5	33	13	-	-	-	-	-	CLAY	
RB-11	30	114	2.1	-	-	81	61	43	37	21	silty SAND SM	
RB-11	40	96	5.0	-	-	100	97	92	87	46	very silty SAND SM-ML	
RB-11	50	115	3.9	-	-	92	84	71	65	32	silty SAND SM	
RB-11	60	107	3.8	-	-	94	86	71	60	32	silty SAND SM	
RB-11	70	103	3.8	-	-	98	91	70	57	35	silty SAND SM	
RB-11	80	127	3.3	-	-	92	91	70	57	35	silty SAND SM	
RB-11	90	97	8.2	2.3	NP	-	-	-	-	-	sandy SILT	

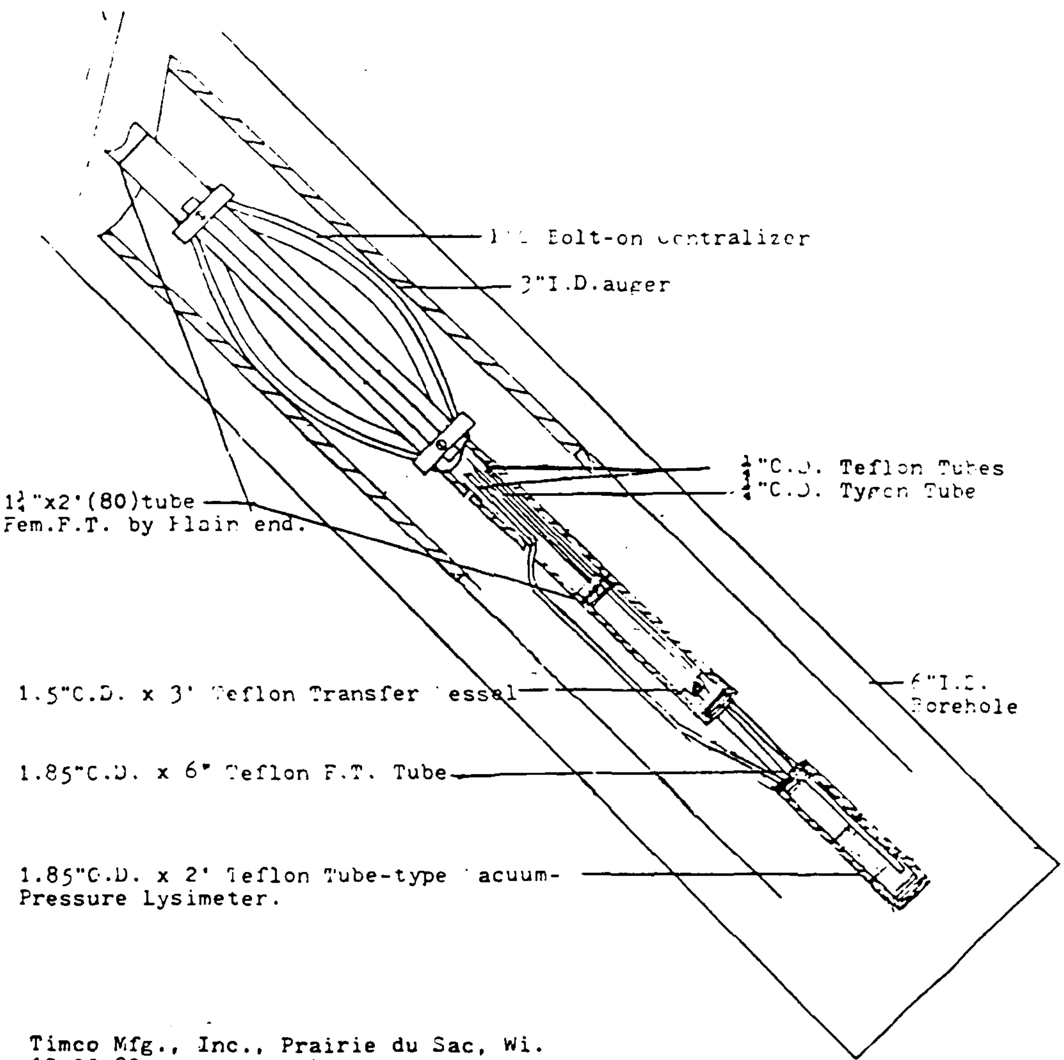
Lysimeter	Location	Bearing from Hole Collar	Hole Angle From Horizontal	Hole Depth (Slant Ft.)	Porus Cup Center (Slant Ft.)	Sand Pack (Slant Ft.)	Bentonite (Slant Ft.)	Comments
LF-01-01	LF #1	N28°W	50°	63.0'	62.0	63 - 59	59 - 56	located along south boundary
LF-01-02	LF #1	N88°W	50°	59.0'	58.0	59 - 55	55 - 52	located along drainage channel
LF-02-01	LF #2	S ~~N~~37° ~~E~~ W	50°	65.0'	64.0	65 - 57	57 - 53	located along east boundary
LF-02-02	LF #2	S4°E	50°	48.0'	47.0	48 - 44	44 - 42	located on a haul road within the landfill
LF-03-01	LF #3	N8°E	45°	64.0'	63.0	64 - 59	59 - 52.5	damaged/replaced with LF-03-02
LF-03-02	LF #3	N10°E	50°	64.0'	63.0	64 - 59	59 - 52.5	located on south boundary
LF-04-01	LF #4	N78°E	50°	53.0'	52.0	53 - 49	49 - 46	damaged/replaced with LF-04-02
LF-04-02	LF #4	N75°E	50°	60.0'	59.0	60 - 54	54 - 48	located on west boundary
RB-11-01	RB-11	S28°W	50°	51.5'	50.5'	51.5 - 46.5	46.5 - 42.5	located on east side

Table 3

F.M. Fox Associates

Attn: Steve Brewer

45 degree Angular Installation Utilizing Teflon Lysimeter
With Transfer Vessel.



Timco Mfg., Inc., Prairie du Sac, Wi.
12-20-83
Hope Weitzel

MANUFACTURER'S LYSIMETER DETAIL

Job No: **0111210**

FOX Consulting Engineers and Geologists

Date: **JUNE 13,1984**

Figure **B-1**

—COMPLETE MONITORING LINE
—SAMPLERS
—LYSIMETERS

TIMCO MFG., INC.

851 FIFTEENTH STREET
PRAIRIE DU SAC, WISCONSIN
53578

—PVC SAND POINTS
—PVC WELL SCREENS
—SCREENS FOR DEWATERING

Telex # 9109970034
Area Code 608-643-8534

TIMCO LABORATORY EVALUATION

Type: Transfer Vessel
Size: 1.25 inches I.D.-1.66 inches O.D. (31.75 mm I.D.-42.16 mm O.D.)
Construction: Polytetrafluorethylene (Teflon®)
Date: March 12, 1984

Purpose of Evaluation: To evaluate the performance of the transfer vessel during angled installation with emphasis on the ability of the ball check to hold under low or zero sample.

Installation Procedure: The transfer vessel was attached to a wooden pole to support the vessel when laid on an angle. A flask with a 2 hole stopper was used to simulate a lysimeter to supply water to the transfer vessel.

Testing Procedure: The transfer vessel was set at a 45° angle to the vertical. Pressure was first applied to the transfer vessel dry to test the holding of the check. Then 50 ml of tap water was added from the flask and it was attempted to extract the sample from the transfer vessel. This was repeated a second time. A 100 ml of tap water was also added and sampling again done. Pressure was always applied with a hand pump. The holding of the check and the amount of the sample collected was recorded each time.

TEST RESULTS

Amount of Water Added (ml.)	Amount of Sample Received (ml.)	Ball Check Holding yes/no
0	0	no
50	27	yes
50	47	yes
100	93	yes

Analysis: The check would not hold under dry conditions. At 50 ml of water sample, recovery was accomplished. The sample loss here as in the other samples can be explained by the sample tube not being completely extended to the bottom of the chamber plus that sample held below the check. The check did hold on all occasions after water was added. Small leakage did occur but is considered insignificant due to its minute amount.

TIMCO MFG.

—COMPLETE MONITORING LINE
—SAMPLERS
—LYSIMETERS

TIMCO MFG., INC.

851 FIFTEENTH STREET
PRAIRIE DU SAC, WISCONSIN
53578

—PVC SAND POINTS
—PVC WELL SCREENS
—SCREENS FOR DEWATERING

Telex # 9109970034
Area Code 608-643-8534

Conclusion: Polytetrafluoroethylene (Teflon®) is a very different material. It is a material hard to seal when dry as seen in the tests. It does seal with the presence of water. In the line of lysimetry this characteristic seems to work alright since the check need not hold if no sample is there to be extracted. If there is a sample the check will hold although sample recovery could possibly not occur if the sample were approximately 25 ml or less due to sample tube not being extended to chamber bottom. If the sample is greater than 25 ml. Sampling should be successful.

Tim Fishbaugh

Tim Fishbaugh

Teflon® is a registered trademark of E.I. duPont

TIMCO MFG.

—COMPLETE MONITORING LINE
—SAMPLERS
—LYSIMETERS

TIMCO MFG., INC.

851 FIFTEENTH STREET
PRAIRIE DU SAC, WISCONSIN
53578

—PVC SAND POINTS
—PVC WELL SCREENS
—SCREENS FOR DEWATERING

Telex # 9109970034
Area Code 608-643-8534

January 25, 1984

F.M. Fox & Associates
3412 Byrn Mawr Drive
Albuquerque, NM 87107

Attn: Steve Brewer

Dear Mr. Brewer:

This letter is regarding the cleaning of the teflon lysimeter as purchased under our invoice number 82309.

Timco goes through a procedure of first cleaning the basic body parts, except the filters, in a warm water mild detergent solution. It is then rinsed in distilled water. Whoever handles the teflon filters wears white cotton gloves. No machining oils are used on these products. When the lysimeters are pressure tested, they are submersed in distilled water only, and then sealed in plastic tubes.

If you have any questions or comments, please contact me.

Sincerely,

Hope Weitzel

Hope Weitzel
Sales/Production Manager

HW:ja

TIMCO MFG.

NOTE:

The original site maps prepared by FM Fox & Associates were on a 24"x 36" blueline format. Science Applications, Inc. has taken the liberty of including only xerox copies of the appropriate areas of these maps. These copies are at the original scale of 1" = 400' (legend and scale attached). Should you require a set of the original maps please contact Science Applications, Inc. at (505) 247-8787.

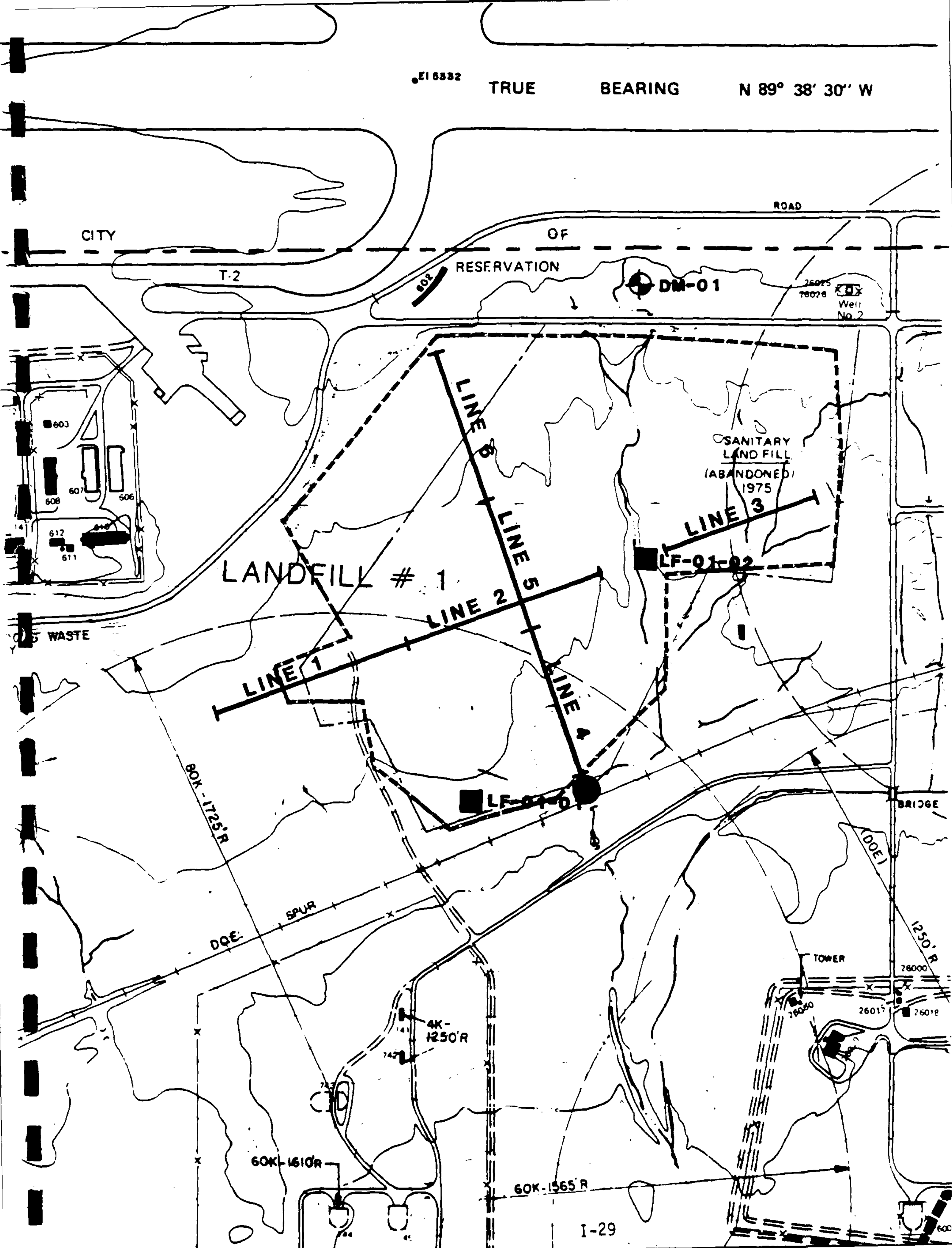
LEGEND

■■■■■■	APPROXIMATE GEOLOGIC CONTACT
Ra	RECENT ARROYO DEPOSITS
Qal	QUATERNARY ALLUVIUM
	DEEP GROUNDWATER MONITOR WELL
■	LYSIMETER ACCESS BOX
●	EXPLORATION TEST HOLE
	SEISMIC LINE LOCATION
	LANDFILL BOUNDARY
▲	SEWER EASEMENT TEST HOLES

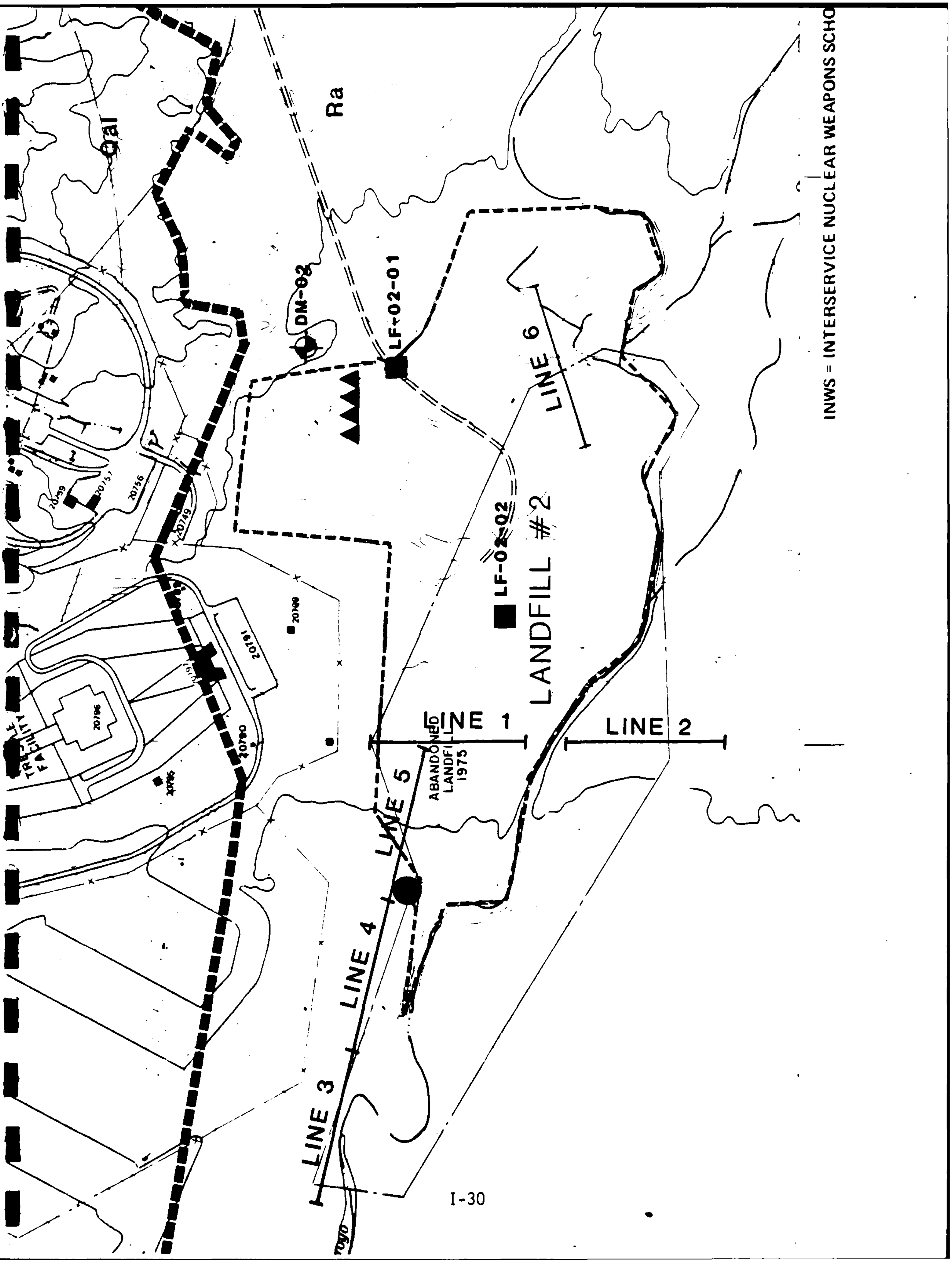
400 200 0 400 800 1200

SCALE IN FEET

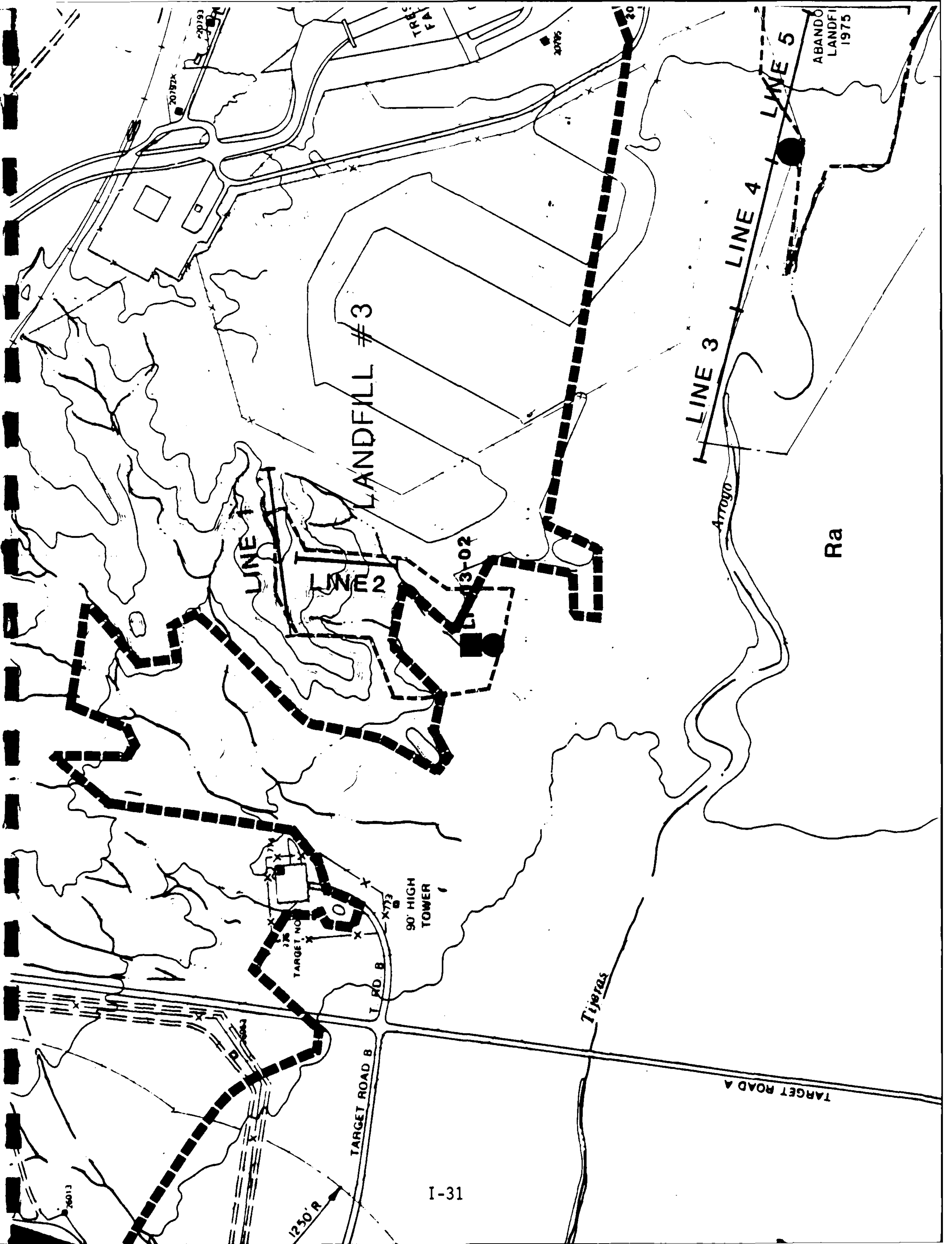
CONTOUR INTERVAL 5 FEET

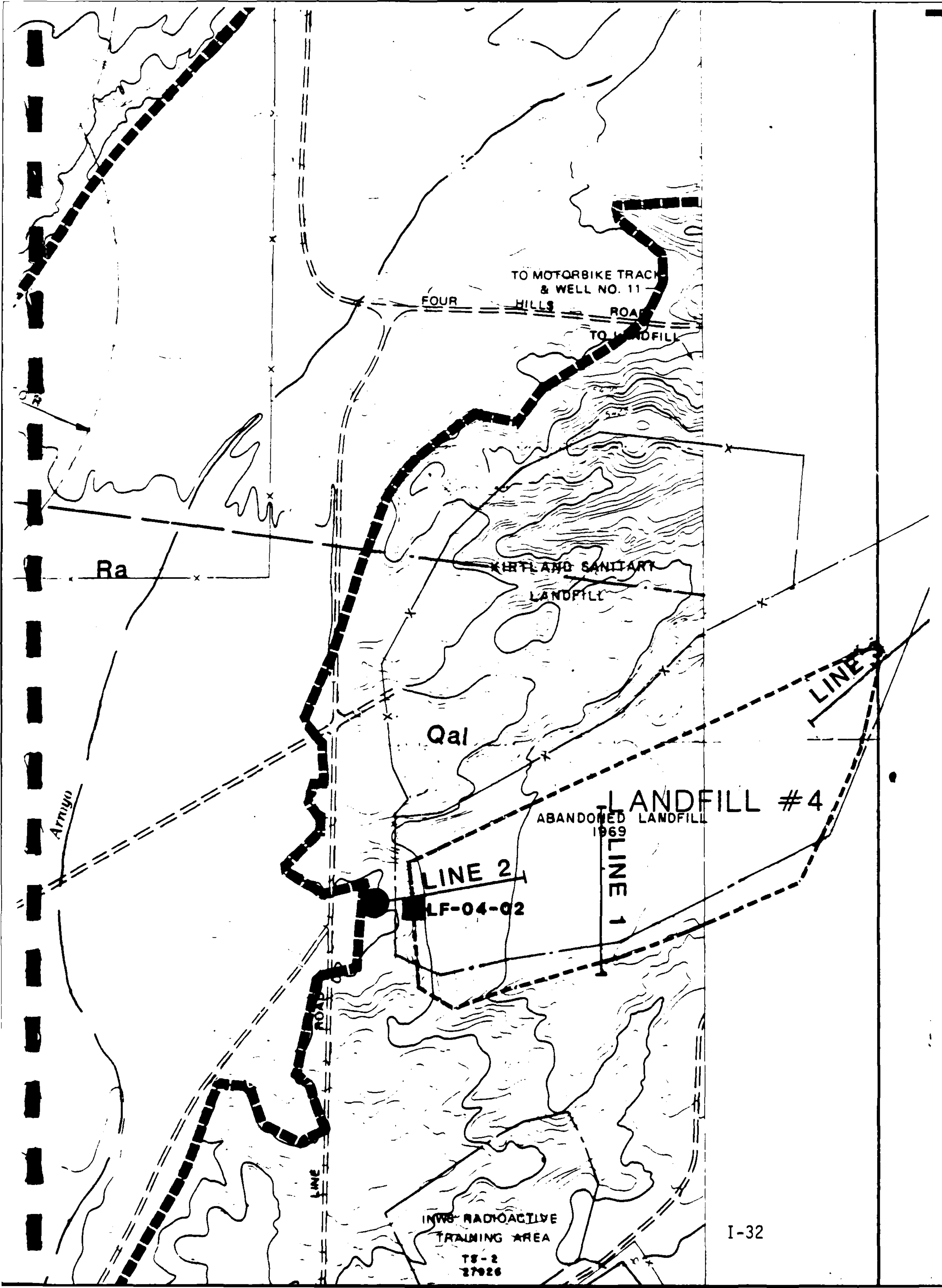


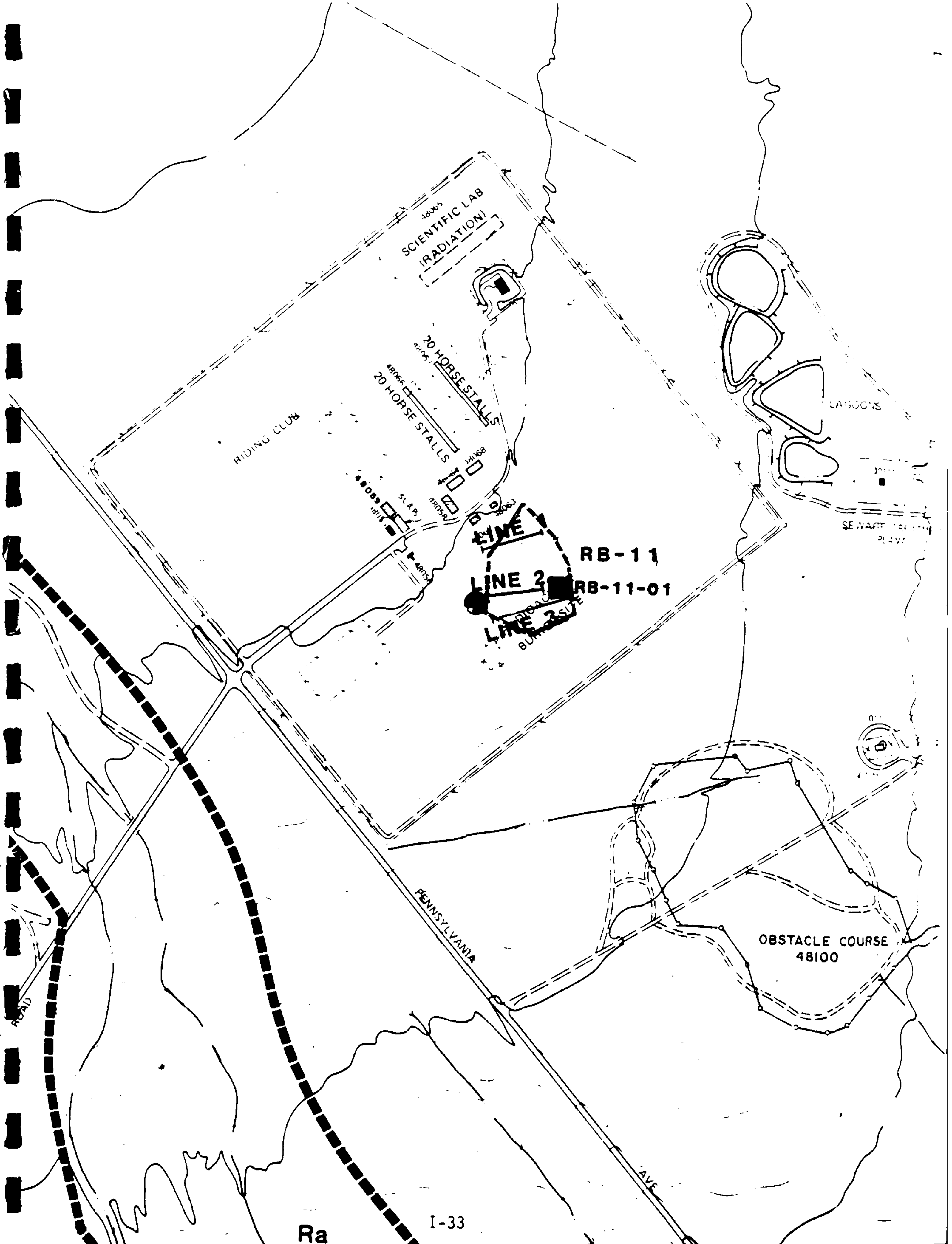
TRUE BEARING N 89° 38' 30'' W
ROAD
CITY OF RESERVATION
T-2
DM-01
Well No 2
SANITARY LAND FILL (ABANDONED) 1975
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
LANDFILL # 1
LF-01-02
WASTE
80K-1725'R
BRIDGE
(DOE)
1250'R
DOE SPUR
TOWER
4K-1250'R
60K-1610'R
60K-1565'R



INWS = INTERSERVICE NUCLEAR WEAPONS SCHO
LANDFILL #2
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
LF-02-01
LF-02-02
DM-02
ABANDONED LANDFILL 1975
Ra
Qal
20790
20791
20799
20786
20756
20749


LANDFILL #3
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
Ra
Arroyo
Tijeras
90' HIGH TOWER
TARGET ROAD B
T. RD B
TARGET ROAD A
1250' R
1975


TO MOTORBIKE TRACK
& WELL NO. 11
FOUR HILLS ROAD
TO LANDFILL
KIRTLAND SANITARY
LANDFILL
Ra
Qal
LANDFILL #4
ABANDONED LANDFILL
1969
LINE 1
LINE 2
LINE 3
LF-04-02
Armijo
ROAD
LINE
INWS RADIOACTIVE
TRAINING AREA
TS-2
27926


SCIENTIFIC LAB
(RADIATION)
20 HORSE STALLS
20 HORSE STALLS
RIDING CLUB
SLAB
LINE
LINE 2
LINE 3
RB-11
RB-11-01
LAGOONS
OBSTACLE COURSE
48100
PENNSYLVANIA
AVE
ROAD
Ra

Appendix J
SAFETY PROGRAM

SAFETY PROGRAM

The following items were implemented as part of the KAFB IRP Phase IIB field safety program:

OBSERVANCE OF KAFB REGULATIONS

SAI and its subcontractors observed and cooperated with all base regulations regarding access, vehicle operation, personal conduct, etc. while on base. Specifically: (1) all personnel obtained passes to enter base property and checked in and out through base guard stations, (2) all vehicles used on site carried current registration and inspection information, (3) all vehicle/equipment operators carried valid driver/operator licenses, (4) all local base covering items such as speed limits and seat belts were followed and (5) military police instructions recieved priority over all else.

SANITATION

Drinking waster was obtained from local potable sources and dispensed from cooler cans using disposable paper cups. Every effort was made to establish and maintain sanitary job conditions.

No food was consumed on the drilling site. Employees thoroughly washed their hands, forearms and face before consuming food or beverages other than water held in disposable cups.

FIRST AID AND MEDICAL FACILITIES

SAI and its subcontractors had available to them first aid kits for treatment of minor injuries. All on site project personnel were made familiar with the location of the nearest emergency medical care facility should emergency treatement have been required.

DRILLING ACTIVITIES

A. Only qualified personnel with related field experience were used for this work.

B. All drivers had valid driver's license.

C. Personal clothing standards were enforced. Minimum requirements are listed below:

   1. Short sleeve shirt

   2. Long trousers

   3. Safety toe leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes were not acceptable.

   4. Hard hats were required since this is a construciton activity and will take place on and around overhead heavy equipment.

   5. During the placement of silica sand packs used in lysimeter construction all personnel wore disposable particulate filter masks.

D. An SAI representative was on site and acted as the job site safety officer responsible for crew safety.

SEISMIC REFRACTION GEOPHYSICAL SURVEY

A. This effort was carried out by Fox and Associates personnel. Fox was assumed to have provided all associated safety training. SAI personnel acted as observers only.

B. The energy sources were 1/2- to 1-pound kinepac explosive charges or a 12-pound sledge hammer. The kinapac exposives consisted of two-compounds that were mixed only at the shot point. Detonation was achieved using

electric blasting caps. All kinepac materials were handled according to Class C ordinance regulations up to the point of mixture, at which time the kinepac materials are up-graded to Class A ordinance. Blasting caps were handled according to Class A ordinance regulations at all times.

C. Approval for the use of the materials above was sought and obtained from the appropriate KAFB personnel prior to initiation of the survey.

D. All attempted detonations were successful.

E. All personnel were familiar with the location of the nearest emergency medical facility as well as direct routes to that facility.

MONITORING WELL DEVELOPMENT

A. All development and/or flushing of monitoring wells was performed by persons dressed in the following minimum protective items:

1. Long sleeve shirt
2. Long trousers
3. Leather boots, work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes were <u>not</u> acceptable.

B. Field personnel stood upwind from discharge point when bailing

C. Odorous water conditions were not encountered.

D. All equipment used in well development and/or flushing was cleaned and rinsed with fresh water before being used in another well.

SOIL AND WATER SAMPLING

A. All sampling activities were conducted by persons wearing at least the minimum protective items listed above under DRILLING ACTIVITIES.

B. Field personnel stood upwind from the sampling locations and while handling samples.

C. Odorous soil, water or site conditions were not encountered.

D. Sample containers were clean, resistant to solution and breakage, and had leakproof seals. If these conditions were not satisfied, the container was not be used.

Appendix K

SUMMARY OF INVESTIGATIONS

SUMMARY OF INVESTIGATIONS

The following section includes a tabular summary of pertinent investigation results related to the KAFB IRP. The findings are presented in two categories: (1) regional conditions, and (2) site conditions.

I GENERAL CONDITIONS

- The Santa Fe Formation exists to depths of over 450 ft BGS as confirmed by wells DM-01, DM-02 and KAFB production well records.
- Analyses of July 1983 water level data indicate depths to water of over 350 ft, BGS at all study sites and that hydraulic gradients are generally to the north at rates of 5 to over 25 feet per mile. These conditions were confirmed by wells DM-01 and DM-02 (Plate II).
- KAFB production data indicate the water table in the KAFB-southern Albuquerque area is declining at a rate of 2.7 feet per year.
- There are several potential contaminant source areas in the southern Albuquerque area other than KAFB. These potential source areas include Tijeras Canyon, the south Eubank Avenue landfill to the east of KAFB, and abandoned City of Albuquerque landfills and industrial waste sites west of KAFB (Plate I).

II SITE CONDITIONS

The following site-by-site descriptions of investigations are presented in outline form.

<u>Landfill No. 1 (LF-01)</u>

Background

Aerial Extent:	30-40 acres
Period of Operation:	1965-1975
Method of Operation:	Trenches and area fill.
Materials Buried:	General refuse, harcfill and probably some potentially hazardous waste

Field Conditions

- Geologic setting:

  North rim of Tijeras Arroyo in unconsolidated Santa Fe Formation sediments. No geologic structures in area.

- Ground-water conditions:

  Water table elevation is about 4895 ft (420 ft, BGS) with hydraulic gradient to north at 7 ft per mile.

- Cover:

  Variable, with gentle slopes appearing well covered. Steeper slopes in south-central area contain exposed debris.

- Drainage:

  Site is crossed by open-channel eliminate of north KAFB storm drainage system. Flow is entirely precipitation-dependent.

Field Investigations

- Investigation Techniques Used:

  Seismic refraction geophysical survey to determine vertical and lateral extent of LF-01.

  Determination of landfill boundary

  Collected data from 100-foot vertical exploratory borehole LF-01-E

  Installed and sampled ground water monitoring well DM-01

  Installed and sampled two slant lysimeters LF-01-01 and LF-01-02

- Seismic refraction geophysical survey:

  Total of 3600 feet covered in 6 lines. Fill depth only with cover thickness not discernable.

  Maximum thickness of fill encountered was 30 feet. Landfill boundaries contain areas of no fill.

- Determation of landfill boundary:

  Data for determination included aerial photography, interviews, geophysical survey and field reconnaissance. Interpretation of data was conservative.

  Boundaries surveyed and marked by Scanlon and Associates (closure obtained) (Appendix H)

- 100-foot Vertical Exploratory Borehole LF-01-E

  USCS material classification log and at 5- and 1-foot intervals - analyses for density, moisture, and grain size (Appendix I)

Drilled section is dominantly clean to silty sand. Silt and clay interval from 24 to 43 feet. This is a vertical borehole.

Natural dry densities range from 78 to 111 pcf and average 98 pcf.

Natural moisture contents vary from 2.9 to 27.0%. Moisture contents greater than 5% are correlatable to proportional increase in silt/clay content.

- Ground Water Monitoring Well DM-01

  Lithologic cuttings log, water level data and one scan-type suite of water analyses (Appendices F and G)

  Lithologic log indicates Santa Fe Formation conditions persist to 480 feet. Samples not retained.

  Water level data (February 1984) indicate water table is 420 feet below ground surface which corresponds to an elevation of 4895 ft.

  An analysis of a single water sample detected organic chloride and nitrate at low to trace levels (Appendix G)

  DM-01 is expected to function as a groundwater monitoring site for 16 years (until the year 2000), assuming water usage rates remian constant

- Installed and Sampled Slant lysimeters LF-01-01 and LF-01-02:

  Materials classification log, one scan-type soil analysis at each installation

  Both lysimeter installations are in working order. Attempts to collect liquid samples by application of 14 to 17 in. Hg vacuum unsuccessful.

  The soil sample analysis from 48 ft, BGS, detected oil and grease at trace to low concentrations.

Landfill NO. 2 (LF-02)

Background

Aerial Extent: 50-70 acres
Period of Operation: 1943-1965
Method of Operation: Area fill
Materials Buried: General refuse, one report of hazardous wastes.

Field Conditions

- Geologic setting:

  Site lies in unconsolidated alluvium of the Tijeras Arroyo flood plain. No geologic structures in the area.

- Ground-water conditions:

  Water table elevation is about 4900 ft (380 ft BGS) and hydraulic gradient is to north at 8-10 ft per mile.

- Cover:

  Variable with gentle slopes in southern portion appear well-covered. Gentle slopes in northern portion have had cover material reworked in attempts to improve surface drainage. Hardfill type refuse is for uncovered and exposed on north bank of Tijeras Arroyo channel approximately 4300 ft.

- Drainage:

  The active channel of Tijeras Arroyo forms the southern boundary of the landfill. The landfill site is crossed by two sewage pipelines (Figure 5.5). The transmission line from the sewer lagoons to the KAFB golf course has a history of failures causing liquid release in the landfill. Earth moving activities have encountered refuse. The Tijeras Interceptor is owned by the City of Albuquerque and piping-type soil failures along its trace are common in the vicinity of LF-02. Open unlined drainage channel crosses western end of landfill near LF-02-E. Uncontrolled drainage from the TRESTLE and ARES facilities is apparent.

Field Investigations

- Tasks accomplished:

  Seismic refraction geophysical survey.

  Determination of landfill boundary

  Collected data from 100-foot verticle exploratory borehole LF-02-E.

Installed and sampled ground water monitoring well DM-02.

Installed and sampled two slant lysimeters LF-02-01 and LF-02-02.

- Seismic refraction geophysical survey:

  Covered total of 3350 feet in 6 lines. Fill depth only with cover thickness not discernable. Maximum thickness of fill encountered was 30 feet. Landfill boundaries contain areas of no fill.

- Determination of landfill boundary:

  Data for determination included aerial photography, interviews, geophysical survey and field reconnaissance. Interpretation of data was conservative. Location of boundary in north west area is approximate.

  Boundaries surveyed and marked by Scanlon and Associates; closure was not complete. Landfill boundary keyed to channel of Tijeras Arroyo which was not surveyed (Appendix H)

- Data from 100-foot vertical exploratory borehole:

  USCS material classification log and 5- and 10-foot intervals-analyses for density, moisture, and grain size (Appendix I).

  Drilled section is predominantly silt, sand silt and clay with sandy intervals at 23 to 38 feet and 88 to 91 feet.

  Natural dry densities range from 73 pcf to 124 pcf and average 103 pcf.

  Natural moisture contents range from 1.1% to 18.6%.

  Grain sizes of sandy materials are typically very fine to fine sand. Silty materials have Atterberg liquid limits of 21 to 28 and no plasticity index. The clayey material encountered at 95 ft has an Atterberg liquid limit of 41 and plasticity index rating of 20.

- Ground Water Monitoring Well

  Lithologic cuttings log, water level data and one scan-type suite of water analysis. (Appendices F & G).

  The lithologic log indicates Santa Fe Formation conditions persist to 450 feet. Samples not retained.

  Water level data (February 1984) indicate water table is 378 feet below ground surface which corresponds to an elvation of 4904 ft, MSL.

An analysis of a single water sample detected organic chloride, organic bromide, and nitrate at trace to moderate concentrations (Appendix G)

DM-02 is expected to function as a ground-water monitoring site for 18 years (until the year 2002), assuming water usage rates remain constant.

- Installed and sampled slant lysimeters LF-02-01 and LF-02-02:

Material classification log, one scan-type soil analysis at each installation (See Appendices G & I)

Both lysimeter installations are in working order. Attempts to generate liquid samples by application of 14 to 17 in. Hg vacuum were unsuccessful.

The soil sample analysis from 37 ft, BGS, detected oil and grease at low to trace concentrations. These findings were confirmed by duplicate analysis.

Landfill No. 3 (LF-03)

Background

Aerial Extent:	5-10 acres
Period of Operation:	Early 1970's to 1977
Method of Operation:	Area fill
Materials Buried:	General refuse

Field Conditions

- Geologic setting:

  North rim of Tijeras Arroyo on isolated spur of semi unconsolidated to unconsolidated Santa Fe Formation consolidated above Tijeras flood plain alluvium.

- Ground-water conditions:

  Water table elevation is about 4900 ft, MSL (380 ft, BGS) and hydraulic gradient is to north at 10 ft per mile.

- Cover:

  Consistent, cover starting to erode at south-central area. Area is well drained with no waste exposed to flow paths.

- Drainage:

  None

Field Investigations

- Tasks accomplished:

  Seismic refraction geophysical survey.

  Determined landfill boundary.

  Collected data from 100-foot exploratory borehole LF-03-E.

  Installed and sampled one slant lysimeter LF-03-01.

- Seismic refraction geophysical survey:

  Total of 900 feet covered in 2 lines. Fill depth only-cover thickness not discernable. Maximum thickness of fill encountered was 35 feet.

- Determination landfill boundary:

  Data for determination included aerial photography, interviews, geophysical survey and field reconnaissance. Interpretation of data was conservative.

Boundaries surveyed and marked by Scanlon and Associates. Closure obtained (Appendix H).

- Data from 100-foot verticle exploratory borehole (LF-03-E):

  USCS material classification log and at 5- and 10-foot intervals-analyses for density, moisture, and grain size (Appendix I)

  Drilled section is predominantly silty sand. Clay intervals at 48 to 70 feet and 84 to 98 feet. This borehole is vertical

  Natural dry densities range from 99 pcf to 114 pcf and average 106 pcf.

  Natural moisture contents range from 1.4% to 22.0%. Moisture content greater than 6% generally correlatable to proportionate increase in silt/clay content.

  Grain sizes of sandy materials range from medium to very fine grained. The clayey zones have Atterberg liquid limits of 54 and 34 with plasticity indices of 29 and 14.

- Installed and sampled lysimeter LF-03-01:

  Material classification log, one scan-type soil analysis. (See Appendices G & I).

  LF-03-01 was found to be non-functional and was replaced with a completely new borehole and lysimeter on 9 June 1984, and designated as LF-03-02 (Appendix I).

  Geochemical data for the LF-03 site were obtained from the analysis of a soil sample taken during LF-03-01 construction of LF-03-01 at 44 ft BGS. Analysis shows no analates present in concentrations above laboratory detection limits.

Landfill No. 4 (LF-04)

Background

Aerial Extent:	15-20 acres
Period of Operation:	1964 to 1969
Method of Operation:	Trenching and area fill
Materials Buried:	KAFB and City of Albuquerque general refuse

Field Conditions

- Geologic setting:

  On south rim of Tijeras Arroyo in semiconsolidated to unconsolidated Santa Fe Formation materials. No geologic structures in the area.

- Ground-water conditions:

  Water table elevation is about 4896 ft, MSL (500 ft, BGS) and hydraulic gradient is to north-northwest at 20 ft per mile.

- Cover:

  Consistent with all areas well covered. No waste exposed to flow paths. Site is generally well drained. Localized depression on western end of landfill is causing ponding conditions and runoff from ponding area is causing erosion of cover material on west face.

- Drainage:

  Unnamed drainage 0.5 miles to south and east. Tijeras Arroyo 1200 feet to west.

Field Investigations

- Tasks accomplished:

  Seismic refraction geophysical survey.

  Determination landfill boundary.

  Collected data from 100-foot exploratory borehole LF-04-E.

  Installed and sampled one lysimeter LF-04-02

- Seismic refraction geophysical survey:

  Total of 1600 feet covered in 3 lines. Depth of fill only with cover thickness not discernable. Maximum thickness of fill encountered was 35 feet. Landfill boundaries contain areas of no buried waste.

- Determination of landfill boundary:

  Data for determination included aerial photography, interviews, geophysical survey, and field reconnaissance.

  Boundaries surveyed and permanently marked by Scanlon and Associates. Survey data were keyed to LF-06 fence line which was not surveyed. Closure not complete (Appendix H).

- Data collected from 100-foot vertical exploratory borehole LF-04-E:

  USCS material classification log and at 5- and 10 foot intervals-analyses for density, moisture, and grain size (Appendix I).

  Drilled section is composed of a mixture of silty sand, sandy silt, clay and gravel. Grain size of sandy fraction ranges from coarse to very fine sand. Silty fractions range from 9% to 75%. Clayey materials encountered at 46 ft to 68 ft, BGS have an Atterberg liquid limit of 26 and a plasticity index of 7.

  Natural dry densities range from 97 pcf to 125 pcf and average 109 pcf.

  Natural moisture content range from 1.6% to 14.5%. Moisture contents greater than 10% are correlatable to proportional increases in clay/silt content.

- Installed and sampled slant lysimeter LF-04-01

  USCS Material description log, one scan-type soil analysis (Appendices G & I).

  LF-04-01 required several attempts before successful completion. The materials encountered are summarized on the materials log for LF-04-01. The compatibility material logs were verified by an on-site geologist. The lysimeter assembly has been identified as LF-04-02.

  Lysimeter installation LF-04-02 is in working order. Attempts to generate liquid samples by applications of 14 to 17 in. Hg vacuum were unsuccessful.

  Soil sample analyses from 44 ft BGS vertical detected only oil and grease at trace to low concentrations.

Radioactive Burial Site No. 11 (RB-11)

Background

Aerial Extent: About 2 acres
Period of Operation: 1960 to 1971
Method of Operation: Trench and cover as needed.
Materials Buried: Irradiated animal carcasses and small ammounts of chemicals

Field Conditions

- Geologic setting:

  On Sandia-Manzano piedmont plain in coarse-grained, marginal portion of Santa Fe Formation. Materials are unconsolidated to semi-consolidated. Sandia Fault (normal fault, down to west, displacements >2700ft) is thought to cross KAFB within 300 feet of RB-11. This location is unconfirmed. Depth to bedrock approximately 800 feet under RB-11.

- Ground-water conditions:

  Water table elevation is estimated to be 4945 ft, MSL (500 ft, BGS) or deeper and the hydraulic gradient is north-northwest at over 25 feet per mile. Site is located on an area considered to be part of the Albuquerque-Belen Basin ground water recharge area.

- Cover:

  Site is well covered. Disposal activities were confined to trench sites. One trench has a surface depression involving 30-40 sq. ft.

- Drainage:

  Trenches are well covered. Compacted nature of cover inhibits infiltration. Arroyo del Coyote channel, located 1400 feet to southwest Pennsylvania Avenue, prevents direct surface runoff form RB-11 to Arroyo del Coyote. Potential surficial liquid release event associated with sewage lagoons to northeast of site would not involve the RB-11 site.

Field Investigations

- Tasks accomplished

  Seismic refraction geophysical survey.

  Determiantion of Burial site boundary.

Collected data from 100-foot vertical exploratory borehole RB-11-E.

Installed and sampled lysimeter RB-11-01.

- Seismic refraction geophysical survey:

  Total of 800 feet covered in 3 lines located over known trench sites. Fill depth data only-cover thickness not discrenable. Maximum trench depth encountered was 24 feet. Areas between trenches are apparently barren. Data are summarized on Figures 5.14 and 5.15

- Determination of burial site boundary:

  Data for determination included aerial photography, interviews, geophysical survey and field reconnaissance. Interpretation of data was conservative. Boundaries surveyed and marked by Scanlon and Associates Closure (Appendix H). Interviews indicate presence of one additional burial pit about 50 ft. to west. No exploration data available due to presence of one-horse stable at approximate site location. This area was not included within site boundary.

- Data collected from 100-foot vertical exploration borehole:

  USCS materials log and at 5- and 10-foot intervals-analyses for density moisture and grain size (Appendix I)

  Drilled section is composed of silty sand and sandy silt. Grain size of sandy fraction is typically medium to very fine sand. Silt fractions range from 26% to 71%. The clayey zone at 22 to 27 feet has an Atterberg liquid limit of 2.3 and is non-plastic.

  Natural dry densities range from 96 pcf to 127 pcf and average 108 pcf

  Natural moisture contents vary from 1.2% to 9.5%.

- Installed and sampled slant lysimeter RB-11-01:

  USCS material log, one scan-type soil analyses

  Soil sample analyses from 40 ft, BGS, vertical show concentrations of mercury and silver at laboratory detection limits.

Fire Control Training Area (FTA)

Background

Aerial Extent:	Approx. 2 acres
Period of Operation:	Approx. 1976 to present (Active facility)
Method of Operation:	Present-Spray injet fuel on pad and mock-up and extinguish. Past-Saturate ground with water, apply fuel an other materials and estinguish. Residuals left in place. Past activies involved circular and rectangular pits east of present pad. Pits re filled and were not investigated.
Materials Involved:	Present-JP-4 (jet fuel), AFFF Foam. Past-fuels with lesser amounts of undefined flammable materials.

Field Conditions (Figure 5.16)

- Geologic setting:

  On north rim of Tijeras Arroyo in unconsolidated Santa Fe Formation sediments. No geologic structures in area.

- Ground-water conditions:

  Water table elevation is estimated to be 4897 ft, MSL and hydraulic gradient is to northeast at about 7 feet per mile.

- Cover:

  Present activities conducted on concrete pad about 9 inches thick. Pad is fractured.

- Drainage:

  Present activity area graded flat. Ponding potential not determined. Two strom drains discharge 150 feet east of pad. Storm drains feed ponding area 400 feet to south. Petroliferous residua observed in storm drain discharge. Vegetation is ponding area helty and abundant.

Field Investigations

- Taks accomplished

  Drilled and smpled 10 shallow boreholes.

- Data collected from 10 shallow boreholes

  Borings arrayed in 3 hole x 3 hole grid with 1 control 300 feet to north. All borings to 10 feet except for one 20-foot boring near center of pad.

USCS materials logs of borings around perimeter of pad indicate largely sands with varying amounts of silt overlying a clay zone at depths of 6 to 9 feet. The deep boring indicates upper sandy zone is about 1 foot thick and underlain by 11 feet of clay with silty clay in bottom 6 feet.

Soil samples were submitted fo analyses of oil and grease and a total organic halogen scan. Variations of analate concentrations do not correlate to materials changes. The highest values for all analates were found in the centermost borehole (FTA-10) where oil and grease concentrations reached a maximum of 6500 mg/Kg at 15 feet. At 20 feet oil and grease concentrations were 1200 mg/Kg.